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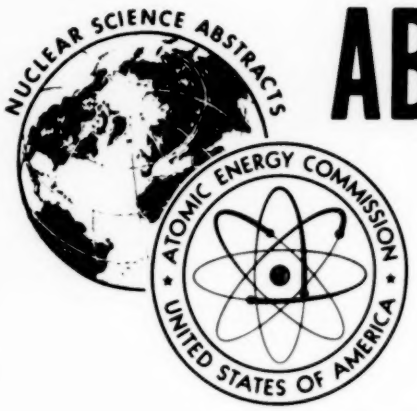

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May 31, 1971

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NUCLEAR SCIENCE ABSTRACTS

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Subjects

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MELPHALAN
  effects on proliferation of cultured antigen-stimulated spleen cells from mice, dose-response curve for, 23:50820
MEMBRANE FILTERS
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MENDELEVIUM
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  stability of divalent state of, 23:49772 (UCRL-18667, pp 277-312)

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Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. **(Los Alamos Scientific Lab., N. Mex.).** Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 21083 and 21281.

20906 (JAERI–4053) ANALYSIS OF URANIUM DIOXIDE. (Japan Atomic Energy Research Inst., Tokyo). Apr 1970. 199p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Methods for determining uranium content, O/U ratio, isotopic composition of uranium, water, released gas, fluorine, chlorine, carbon, nitrogen, and dysprosium in uranium dioxide are presented. The preparation and homogeneity tests of the uranium oxide standard reference samples (JAERI-U1 and -U2) and comparison of the analytical results obtained by 8 participating laboratories in the committee are presented. Methods for determining impurity elements in uranium are included. Most of them were used for the analysis of the standard, reference samples. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 21210, 21459, 21477, and 21542.

20907 (ANL–7760(Pt.2), pp 53–62) BOAT SAMPLING METHODS FOR ANALYSIS OF LEAD AND TELLURIUM IN BIOLOGICAL MATERIALS. Ilcewicz, F. H.; Holtzman, R. B. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969–June 1970.

Two procedures using the atomic absorption boat sampling method were studied: one the direct mounting of a sample, and the other a prior extraction of the sample with APDC (ammonium pyrrolidine dithiocarbamate). Modifications in the method improved the sensitivity, and a detection limit of 0.0004 μg Pb and a precision of about 6% was attained. Extraction of the sample with APDC extended this method to the analysis of tellurium in raw urine with a detection limit of about 0.003 μg Te/ml urine, and to the analysis of lead in heavily salted solutions. (auth)

20908 (CEA-R–4135) VALENCE STATES OF Pu IN INDUSTRIAL SOLUTIONS: DETERMINATION OF Pu(III) IN THE PRESENCE OF PLUTONIUM(IV). Muller, Jean-Paul (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1971. 116p. (In French). Dep. NTIS (U. S. Sales Only).

The conditions under which small quantities of Pu(III) could be spectrophotometrically detected and subsequently measured in the presence of large quantities of Pu(IV) were determined. The method is as follows: Pu(III) is oxidized to Pu(IV) by Fe(III) orthophenanthroline with the formation of Fe(II) orthophenanthroline. Using spectrophotometric and electrochemical measurements, the rapid dissociation of Fe(II) or Fe(III) orthophenanthroline in a 1N sulfuric medium was demonstrated. It was also shown that if a mixture of the two complexes is used, the Fe(II) arising from the dissociation of the Fe(II) orthophenanthroline reacts with the Fe(III) orthophenanthroline by electron or particle exchange to give the Fe(II) orthophenanthroline. This mechanism stabilizes the concentration of Fe(II) orthophenanthroline owing to the presence of Fe(III) orthophenanthroline. The increase in optical density at 510 nm of the Fe(II)/Fe(III) orthophenanthroline mixture after the addition of Pu is proportional to the quantity of Pu(III) in the Pu solution. (auth) (France)

20909 (NLCO–1081) DETERMINATION OF SILICON IN THORIUM METAL BY THE MOLYBDENUM BLUE METHOD. Brueneman, A. L. (National Lead Co. of Ohio, Cincinnati). Feb 1971. Contract AT(30-1)-1156. 13p. (CONF-710207–1). Dep. NTIS.

From 22. Pittsburgh conference on analytical chemistry and applied spectroscopy; Cleveland, Ohio (28 Feb 1971).

The loss of silicon can be prevented during the dissolution of thorium metal chips in a solution of HCl–HF, if the temperature of the dissolution is rigidly controlled. The silicon loss is so temperature-sensitive that the quantity of sample must be closely controlled to minimize the effect of heat of solution. (Particle size might also be an influencing factor.) Because of the presence of thorium, minor modifications of the molybdenum blue procedure were necessary. (auth)

20910 SOME Pb AND Sr ISOTOPIC MEASUREMENTS ON ECLOGITES FROM THE ROBERTS VICTOR MINE, SOUTH AFRICA. Manton, W. I. (Univ. of Texas, Dallas); Tatsumoto, M. Earth Planet. Sci. Lett.; 10: 217-26(Jan 1971).

Five nodules of eclogite, one nodule of garnet peridotite and one sample of kimberlite from the Roberts Victor mine were analyzed for concentrations of U, Th, Pb, Rb, and Sr and isotopic compositions of Pb and Sr. In the eclogites, U content ranges from 0.09 to 0.26 ppM, Th from 0.35 to 1.1 ppM, Pb from 0.79 to 5.5 ppM, Rb from 2.1 to 28 ppM and Sr from 133 to 346 ppM; $^{206}Pb/^{204}Pb$ ratios range from 14.8 to 18.5, $^{207}Pb/^{204}Pb$ from 14.9 to 15.7, $^{208}Pb/^{204}Pb$ from 35.2 to 38.5. The garnet peridotite contains 0.22 ppM U, 0.97 ppM Th, 1.05 ppM Pb, 6.9 ppM Rb and 108 ppM Sr and the kimberlite contains 2.5 ppM U, 30 ppM Th, 37 ppM Pb, 113 ppM Rb and 2040 ppM Sr. The lead in the eclogites has two components, a lead pyroextractable at 1100 to 1200°C and a nonpyroextractable residual lead. In three of the eclogites, which are to some extent altered, a proportion of the pyroextractable lead may be contaminating lead from the kimberlite, but an altered kyanite eclogite does not appear to be contaminated by this same kimberlite. The pyroextractable lead from a less altered eclogite contains a much larger proportion of ^{206}Pb. Compositions calculated for the residual leads vary greatly. In many of the pyroextraction runs the primary eclogitic phases disappeared, and the new phases plagioclase, clinopyroxene and a magnetic iron compound were formed. Reasons for some of the lead being retained by these new phases are not understood. (auth)

20911 POSSIBLE USES OF DESTRUCTIVE METHODS FOR THE DETERMINATION OF NUCLEAR FUEL IN VARIOUS MATERIALS. Markov, V. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). pp 3-26 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970). (In Russian).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB–260(Vol.2); CONF-700701–(Vol.2).

The considerable successes achieved in developing nondestructive methods for analytical control have not, however, diminished the primary importance of precision-type, destructive methods of determination in quantitative accounting for nuclear fuel. The uranium and plutonium content of input and intermediate nonirradiated materials (e.g., in metals, alloys, salts, oxides, carbides and other uranium and plutonium compounds), used in the fabrication of fuel elements, can be determined with fully adequate accuracy for safeguards purposes by the gravimetric, titrimetric,

coulometric, mass spectrometric and the other methods of analysis described. The uranium and plutonium content in high-activity solutions of spent nuclear fuel undergoing regeneration is determined by means of the analytical methods described; account being taken of the characteristic properties of the media analyzed. These methods include in the first place potentiostatic and amperostatic coulometry and also gravimetric, titrimetric, photometric, radiometric, and other methods, including some which involve the use of extraction and chromatography techniques for the separation of various substances. Particular difficulties arise in the determination of plutonium in liquid wastes, i.e., waste solutions. The high beta and gamma activities, and the considerable content of other alpha particle sources (Am, Cm, etc.) make it necessary to separate the plutonium from small volumes of sample and to determine very small plutonium contents by alpha counting. The possibilities of a comparatively rapid practical solution of such problems yielding sufficiently accurate results are examined. However, the determination of a quantity of plutonium by alpha counting makes sense only if its specific alpha activity is known. This can be determined directly by experimental means or calculated from data obtained by analysis of the isotopic composition of the separated plutonium. The recommended methods of ion-exchange and distribution chromatography for plutonium separation for purposes of analysing its isotopic composition by means of alpha-spectrometry and mass-spectrometry or determining directly and more rapidly the specific alpha activity of the separated plutonium, the concentration of which in the solution may be accurately determined by amperostatic or potentiostatic coulometry are discussed. Analysis of solid heterogeneous wastes by destructive methods can be effected only upon complete homogenization of such wastes. With all methods of analytical control the accuracy of the quantitative determination of the substances is governed not only by the precision of the method but by the extent to which the sample is representative. For the analysis of heterogeneous wastes containing relatively small quantities of uranium or plutonium, the homogenization of which is impossible or undesirable, use must be made of known methods of gamma spectrometry and also passive and active types of neutron measurement. (auth)

20912 TITRIMETRIC DETERMINATION OF URANIUM IN PRODUCT, FUEL AND SCRAP MATERIALS AFTER FERROUS ION REDUCTION IN PHOSPHORIC ACID: MANUAL AND AUTOMATIC TITRATION. Eberle, A. R.; Lerner, M. W.; Goldbeck, Clara Gale; Rodden, C. J. (Atomic Energy Commission, New Brunswick, N. J.). pp 27-43 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

A report on which this paper is based was abstracted in NSA as 24: 38712. (J.G.B.)

20913 DETERMINATION OF URANIUM AND PLUTONIUM IN SOLUTIONS OF SPENT NUCLEAR FUELS BY X-RAY FLUORESCENCE ANALYSIS. von Baeckmann, A. (Nuclear Research Center, Karlsruhe, Ger.). pp 45-51 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

X ray spectrometry was applied to the determination of uranium and plutonium in dissolver solutions containing fission-product activities up to 2 Ci. Uranium was measured in the concentration range 0.05 to 1.2 mg/g of solution and plutonium in the range 0.05 to 1.2 mg/g of solution with thorium as an internal standard. Plutonium was determined in the presence of a large excess of uranium (U : Pu ≤ 300 : 1). The relative standard deviation of a single measurement was better than 1% in the range 0.2 to 10 mg/g of solution and better than 3% in the range 0.05 to 0.2 mg/g. The effect of direct γ radiation from the sample on the detector background was minimized by means of lead shielding. This method was used to determine the concentration of uranium in the dissolver solution samples of the first and second EUROCHEMIC safeguards experiment and the concentration of plutonium in the dissolver solution samples of the second EUROCHEMIC experiment. The results are compared with the results of mass spectrometric isotope dilution analysis. (auth)

20914 ISOTOPIC ANALYSIS OF LEAD IN URANOTHORIANITE BY HYPERFINE SPECTROMETRY. Jardy, Alain; Rosset, Robert (Ecole Superieure de Physique et Chimie Industrielles, Paris). Bull. Soc. Chim. Fr.; No. 11, 4173-7(Nov 1970). (In French).

Conditions for the routine isotopic analysis of lead in uranothorianite (^{206}Pb = 50.7%, ^{207}Pb = 4.7%, and ^{208}Pb = 44.6%) by hyperfine spectrometry are described. The analysis band used is the resonance one λ = 4057.8 Å. The source is a device carrying four hollow cathodes. Spectra are obtained with a Hypeac spectrometer, the resolution power of which is 660.000. Lead is separated from the starting samples as a deposit of PbO_2 on the anode then redissolved and deposited as the metal on the hollow cathode by electrolysis. This gives a uniform and adhesive deposit, resulting in a notable improvement in the luminosity and stability of the source. The data obtained show that it is possible in the case of the 206 and 208 isotopes to obtain an accuracy of 0.3% in routine analysis, and 0.1 to 0.2% by multiplying by the number of determinations. (France)

20915 DIGITAL RECORDING OF MASS SPECTRA IN GEOLOGIC STUDIES. I. Stacey, J. S.; Wilson, E. E.; Peterman, Z. E.; Terrazas, R. (Geological Survey, Denver). Can. J. Earth Sci.; 8: 371-7(Mar 1971).

A paper-tape digital recording system is described that was used to determine the isotopic abundance ratios of strontium from geologic samples. The system costs less than $10,000 and proved to be highly reliable during three years of operation. More than 600 analyses were recorded and the results processed by an IBM-360 computer. This procedure improved the precision of analyses from this laboratory by a factor of two. Over a period of 11 months, 16 measurements on the M.I.T. strontium carbonate standard gave a mean value for $(^{87}Sr/^{86}Sr)_n = 0.70797 \pm 0.017\%$. The uncertainty in the results is the standard deviation of the analyses with the $^{86}Sr/^{88}Sr$ value normalized to 0.1194. Over shorter periods of time considerably better precision is indicated. (auth) (Canada)

20916 CATHODE-RAY-EXCITED EMISSION SPECTROSCOPY OF TRACE RARE EARTHS. PART V. DETERMINATION OF DYSPROSIUM. Shrader, Ross E.; Larach, Simon; Kauffunger, R. A. (Radio Corporation of America, Princeton, N. J.). Anal. Chim. Acta; 54: 162-3(Mar 1971).

Cathode-ray-excited emission spectroscopy was used for the determination of trace amounts of dysprosium in a zinc sulfide matrix. Previous studies of the luminescence properties of dysprosium in zinc sulfide have shown that both the intensity and certain features of the emission spectrum of dysprosium were enhanced by the presence of silver ions. Lithium was added as a charge-compensating ion. The detection limit for Dy was 1 to 10 ppB. (J.G.B.)

20917 PHOTOMETRIC DETERMINATION OF MINUTE AMOUNTS OF IODINE IN SILICATE ROCKS. Yonehara, Norinobu; Yoshida, Minoru; Iwasaki, Iwaji (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 43: 3796-3800(Dec 1970).

A rapid and sensitive method for determination of minute amounts of iodine in silicate rocks was developed. A rock was fused with potassium hydroxide, and the cake was treated with water and sulfuric acid. The iodine in the solution was reduced to iodide by sodium sulfite, and was then oxidized to free iodine by sodium nitrite. The free iodine thus obtained was extracted with carbon tetrachloride and then back-extracted with a sodium hydroxide solution. The iodine in this aqueous layer was determined photometrically by a method based on the catalytic effect of iodine on the color-fading of ferric thiocyanate. By the proposed method, amounts of iodine as low as 0.007 μg in a 1-g sample of silicate rocks can be determined. Application to some igneous rock samples gave results with a relative standard deviation of less than 7.2%, except for very low concentrations. (auth)

20918 THE DETERMINATION OF COMPOSITION OF CEMENTED CARBIDES BY MEANS OF X-RAY FLUORESCENCE ANALYSIS. Vavrda, J. Pokroky Praskove Met. VUPM; No. 3, 69-84(1969). (In Czech).

An x-ray fluorescence method that allowed quantitative determination of Co, TiC, NbC, TaC, and Mo_2C in cemented carbides is described. The method was tested on a number of specimens. The influence of surface preparation on the reproducibility of measurements was also studied. The x-ray fluorescence spectrum was measured on a compact specimen ground on a diamond wheel; intensities were measured twice on each specimen at different depths, first after removal of 1 mm and then after removal of a further 2 mm. (Metals Abstr.)

20919 PRECIPITATION OF TITANIUM, ZIRCONIUM, AND THORIUM AND THEIR SEPARATION FROM IRON AND ALUMINUM WITH PHENYLACETIC ACID. Konnov, V. A. (Inst. of Oceanology, Moscow). Zh. Anal. Khim.; 26: 307-11(Feb 1971). (In Russian).

Phenylacetic acid precipitates titanium and zirconium quantitatively from an acid solution. The precipitate composition was determined. The effect of ammonium salts on the isolation of

titanium, zirconium, and thorium was examined. The possibility of the separation of titanium and zirconium from iron and aluminum when iron(III) is reduced to iron(II) was established. It was not possible to separate thorium from chromium and iron under the same conditions. (R.V.J.)

20920 SPECTROPHOTOMETRIC DETERMINATION OF TRACES OF COPPER AND NICKEL IN HIGH-PURITY THORIUM COMPOUNDS. Chan, Kwok-yuen; Tam, Ton-pol. Hua Hsueh; No. 3, 55-61(1969). (In Chinese).

A 10-g sample is dissolved in 20 ml of 6N HNO_3, and the Th is removed by extraction with two 30-ml portions of a 1:1 mixture of TBP and $CHCl_3$. The aqueous solution is evaporated to dryness, and the residue is dissolved in 25 ml of water. Copper is determined by forming the copper–8-hydroxyquinoline (I) complex in the aqueous solution, and extracting the Cu–(I) complex with $CHCl_3$. The extract is washed with NaOH to remove any Al and dried over anhydrous Na_2SO_4 prior to measurement of the extinction at 410 and 580 nm. The Cu content is calculated from an equation. Nickel is determined as the Ni–dimethylglyoxime (II) complex. After formation in the aqueous phase, the Ni–(II) complex is extracted with $CHCl_3$, dried over anhydrous Na_2SO_4, and the extinction is measured at 375 nm. The limits of determination are 0.6 ppM of Cu and 1 ppM of Ni. (Anal. Abstr.)

20921 DETERMINATION OF URANIUM USING BENZOTHIAZINE DYES. Tarayan, V. M.; Ovsepyan, E. N.; Petrosyan, A. A. (Erevan State Univ.). Zh. Anal. Khim.; 26: 322-6(Feb 1971). (In Russian).

The interaction of uranium(VI) with trimethylthionine (Azure II) and tetramethylthionine (methylene blue) was examined. Optimum conditions were found for the extraction–photometric determination of uranium(VI). The molar extinction coefficient was calculated, and a molar ratio of uranium and the reagent in the extracted compound was established. (auth)

20922 DETERMINATION OF HAFNIUM IN RUTHENIUM-HAFNIUM ALLOYS. Golubeva, I. A.; Ponomarev, A. I. (Inst. of Metallurgy, Moscow). Zh. Anal. Khim.; 26: 393-4(Feb 1971). (In Russian).

Electrolysis with a mercury cathode was used for the separation of ruthenium for solutions of the alloy at pH 1 to 2. Following the separation of Ru, the electrolytic cell was cleaned, and hafnium in the solution was determined by titrimetric method. (R.V.J.)

20923 SPECTROGRAPHIC ANALYSIS OF BINARY ALLOYS. COMMUNICATION 2. ANALYSIS OF ZIRCONIUM AND NIOBIUM ALLOYS BY A SPECTROGRAPHIC METHOD. Korneev, V. A.; Zuev, M. T. Zh. Anal. Khim.; 26: 319-21(Feb 1971). (In Russian).

The direct quantitative spectrographic analysis of Zr–Nb alloys within the range of concentrations of 0.5 to 99.5% is possible by a three standard method, and by the rapid standardless three-line method, and a three-step reducer method. The mean square errors are respectively 6, 7, and 9 to 10%. A high-frequency spark as a source of the spectrum excitation and a DFS-8-1 (3 A/mm) spectrograph are used. The second method permits a rapid analysis without using any standard samples. The analysis of one sample by means of two parallel spectra takes 30 min. The analysis of 20 samples takes about 3 hr. (auth)

20924 TWO TYPES OF COLOR REACTIONS OF RARE EARTH ELEMENTS WITH BISAZO-SUBSTITUTED CHROMOTROPIC ACID. Savvin, S. B.; Petrova, T. V.; Romanov, P. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: 297-306(Feb 1971). (In Russian).

A study was made of the color reactions of the rare earth elements with 14 bisazo-substituted chromotropic acids of the anthranilic series and benzene S (with the COOH group in the benzene nucleus in the ortho position to the azo group and without any substituents in the ortho position to the azo group) in aqueous and aqueous ethanol media. Two types of color reactions were observed. Some of the reagents examined form complexes with individual rare earths differing in their strength and spectrophotometric characteristics. (auth)

Isotope Dilution Procedures

Refer also to abstract 21238.

20925 (BNWL-1555) ISODIL: A COMPUTER CODE FOR PROCESSING ISOTOPIC DILUTION MEASUREMENTS FROM SPENT FUEL SAMPLES. Matsen, R. P. (Battelle-Northwe Richland, Wash. Pacific Northwest Lab.). Jan 1971. Contr: AT(45-1)-1830. 61p. Dep. NTIS.

The ISODIL code processes data from isotopic dilution measurements from an irradiated fuel sample into information descriptive of the nuclear transformations that have occurred within the sample. The code analyzes data from either plutonium or uranium–plutonium fuel samples. In addition to printed output, other output features include plots of the measured data and punched cards for input to the DBUFIT least squares burnup code, which is used to obtain cross section information from the data. Equations used in the code are described and use of the code is illustrated with several sample cases. (auth)

20926 DETERMINATION OF TRACES OF THALLIUM BY AN ISOTOPE EXCHANGE REACTION IN THE ORGANIC PHASE. Stary, J.; Kratzer, K.; Zeman, A. (Technical Univ., Prague). Radiochem. Radioanal. Lett.; 6: 1-5(10 Feb 1971).

A new radioanalytical procedure for the highly selective determination of thallium (0.02 to 10 μg of Tl/10 ml) has been developed. The method is based on the homogeneous reaction between thallium(I) diethyldithiocarbamate and labeled thallium(III) diethyldithiocarbamate in carbon tetrachloride. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 21081, 21286, 21406, 21416, and 21426.

20927 (AERE-R-6640) THE SIMULTANEOUS DETERMINATION OF PLUTONIUM ALPHA ACTIVITY AND ^{241}Pu IN BIOLOGICAL MATERIALS BY GEL SCINTILLATION COUNTING. Eakins, J. D.; Lally, A. E. (Atomic Energy Research Establishment, Harwell (England)). Dec 1970. 17p. Dep. NTIS (U. S. Sales Only). UK 15p.

A procedure is described for the simultaneous determination of plutonium α activity and ^{241}Pu in biological materials using a simple gel scintillation counting technique. Plutonium is purified by established methods and finally coprecipitated with an insoluble white ferriphosphate complex, which is suspended in liquid scintillator by a gelling agent and counted. Plutonium α activity is counted with an efficiency of 88% and the minimum detectable level for a 100-minute counting period is 0.3 pCi/24-hour sample. Plutonium-241 is counted with an efficiency of 21% and the corresponding minimum detectable level is 2 pCi/24-hour sample, which compares favorably with other reported procedures. (auth) (UK)

20928 (CONF-700816-(Vol.2), pp 683-96) ANALYSIS OF ATMOSPHERIC GASES. Johns, Frederick B.; Jaquish, Richard E. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The Southwestern Radiological Health Laboratory collects and analyzes radionuclides that occur in the gaseous state in the environment. A variety of samplers are used depending on the type of gas being sampled. The mixtures of gases are separated using low-temperature adsorption and gas–chromatograph techniques. After separation, the quantity of radioactivity is determined by counting. The gases routinely sampled and analyzed are xenon, water vapor, krypton, carbon dioxide, and radon. (auth)

20929 (IEA-213) RADIOMETRIC DETERMINATION OF THORIUM IN BRAZILIAN MONAZITES. Tomida, Elisa Kiyoka; Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jun 1970. 10p. Dep. NTIS (U. S. Sales Only).

The determination of thorium in Brazilian monazite samples was made directly using a gamma spectrometric technique. The method is based on the measurement of the height of the ^{212}Pb photopeak (240 keV). This height was compared with those heights obtained using monazite samples with different thorium contents as standards. The determination of thorium was done in monazite samples in which the thorium content varied from 3.9 to 7.2% ThO_2. The nondestructive method described is in good agreement with the chemical method chosen for comparison, and has the advantage of being fast and simple. (auth)

20930 GROUP SEPARATION OF FISSION PRODUCTS BY CHROMATOGRAPHIC METHOD. Moskvin, L. N.; Kalinin, N. N. At. Energ. (USSR); 29: 458-61(Dec 1970). (In Russian).

A group chromatographic separation of fission products followed by identification using a Ge(Li) spectrometer that separated the highly active admixtures in loop water into separate groups is described. A system of connected columns (the first one filled with AB-17 anionite, the second with photoplastic-4, and the third with cationite Dowex) were used for the separation. The aqueous solution (100 to 250 ml) to be analyzed, containing traces of iodine,

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cesium, barium, lanthanum, and cerium, was acidified with formic acid up to pH = 2 and passed, under pressure, at a rate of 8 to 10 ml/min through the system of columns. In the first column the γ spectra indicated the presence of ^{131}I with no other isotope, in the second column ^{141}Ce and ^{144}Ce were found, and in the elute of the third column ^{137}Cs and ^{134}Cs were present. Thus, the scheme of express chromatography for group separation of fission products in the loop water followed by γ spectrometric identification seemed to show satisfactory results. (R.V.J.)

20931 USE OF EMISSION PEAKS OF XENON PROPORTIONAL COUNTERS FOR X-RAY-RADIOMETRIC DETERMINATION OF TUNGSTEN IN ORES. Bolotova, N. G.; Kotel'nikov, V. V.; Leman, E. P. At. Energ. (USSR); 29: 463-5(Dec 1970). (In Russian).

X-ray radiometric analysis, using ^{60}Co, of some heavy elements, especially tungsten, by means of the emission peaks of xenon proportional counters produced satisfactory data, while direct recording of the K radiation was impossible. Data are given on the xenon proportional counter for determining the content of tungsten in ores. The analysis of antimony–tungsten or tin–tungsten ores by the suggested method becomes complicated because of the condition that the peak of xenon emission with tungsten coincided with the K-line energy of antimony and tin. (R.V.J.)

20932 USE OF GAS FLOW PROPORTIONAL COUNTERS FOR TRITIUM ANALYSIS. Malcolme-Lawes, D. J. (Yale Univ., New Haven). Radiochem. Radioanal. Lett.; 6: 31-8(10 Feb 1971).

The standardization procedure of gas-flow proportional counters and the effect of impurities using external sources and internal tritium sources was studied. (auth)

20933 DETERMINATION OF HAFNIUM IN ZIRCONIUM BY RADIOCHEMICAL METHODS. II. USE OF THE METHOD OF RADIOCHEMICAL CORRECTION WITH SUBSTOICHIOMETRIC PRECIPITATION OF HAFNIUM IN THE FORM OF THE PHOSPHATE. Shamaev, V. I.; Garbauskas, G. K. Radiokhimiya; 12: 673-5(1970). (In Russin).

Results of the experiments indicate that direct determination of hafnium by the method of radiochemical correction with substoichiometric precipitation of hafnium phosphate is possible only when the amount of Zr does not exceed the amount of Hf. (J.G.B.)

20934 RADIOCHROMATOGRAPHIC METHOD FOR ANALYSIS OF THE ALIPHATIC ACIDS C_2–C_8 AND ISOMERIC DECANES LABELED WITH ^{14}C. Syroezhko, A. M.; Selivanov, N. T.; Potekhin, V. M.; Proskuryakov, V. A.; Musakin, A. P. Radiokhimiya; 12: 675-80(1970). (In Russian).

A method was developed for the quantitative radiochromatographic analysis of mixtures of C_2 to C_8 monocarboxylic acids and mixtures of isomeric decanones-2, -3, and -5 labeled with carbon 14. The method can be used to investigate the kinetics of the consumption or accumulation of labeled products in the oxidation of hydrocarbons. (tr-auth)

20935 GAMMA-SPECTROMETRIC DETERMINATION OF URANIUM, THORIUM, AND POTASSIUM IN CENOZOIC BASALTS, ANDESITES, AND DACITES FROM THE KURILE ISLANDS AND THE LESSER CAUCASUS. Kravchenko, S. M.; Semenov, G. S. (Inst. of Minerology, Geochemistry, and Crystallochemistry of Rare Elements, Moscow. All-Union Scientific Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). Dokl. Akad. Nauk SSSR; 193: 437-40(11 Jul 1970). (In Russian).

Two high-sensitivity, low-background NaI(Tl) detectors were used for measuring the hard section of the spectrum at 1.3 to 1.6 (^{40}K), 1.6 to 1.9 (^{214}Po), and 2.45 to 3.8 (^{208}Tl) MeV. Correlation of the results indicated a systematic error of ±20% for Ra and ±12% for Th and K. The minerals examined included: double-pyroxenic tholoids of the basalt-dacite series from the Mendeleev and Golovin Volcanoes in Kanushir Island; double pyroxenic andesites-basalts from the Ebeco and Bogdanovich Volcanoes, Paramushir Island; alkaline basalts from the Vetrii Volcano, same island; moderately alkaline basaltoids from the Kara-Dog Volcano and andesite-basalts, Amassi region; Southwest Armenia; trachi-basalt-trachi-andesite-basalt-rhyalite, Ishlansar Volcano. Study of the results revealed that the ratio of the uranium, thorium, and potassium concentrations in differentiated basaltic magmas may be expressed as $y = a \times k$, where a depends on the initial concentration and k, for the same pair of elements, on the basicity of the magma. The possibility of calculating the degree of concentrating these three elements during the differentiation of the magma may be used to develop and to correct theories in the field of genesis of rocks. (TTT)

20936 DEVELOPMENT OF TECHNIQUES FOR ACTIVE AND PASSIVE ASSAY OF FISSIONABLE MATERIALS. Augustson, R. H.; Menlove, H. O.; Walton, R. B.; (and others) (Los Alamos Scientific Lab., N. Mex.). pp 53-78 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

The generation of nondestructive assay methods proceeds in two phases: the selection and/or measurement of fundamental data providing fission isotope signature, and subsequent development of the basic signature into a functional system and delineation of its capabilities for practical assay applications. Studies of the perturbing effects of non-fissionable matrix materials of various container geometries, using fission detectors and "add-a-gram" probes, are reported. The principal nondestructive assay method generated at Los Alamos is an active method based on characteristic differences in delayed neutron yields from neutron induced fission of the various fission isotopes. This "delayed neutron yield" technique employs repetitive neutron pulsing with periods $\lesssim 1$ second; when this technique is combined with multi-spectra irradiations, the characteristic energy variations in fission cross sections of the different fission species (e.g., fission thresholds) permit incisive discrimination between fissile and fertile materials. In addition, the kinetic (time dependent) response of delayed neutrons provides another signature useful for certain classes of samples. Delayed neutron signatures have the advantage of relatively high penetrability, complete time separation from the interrogating pulse and permit the use of standard counting and data reduction equipment. Neutron sources for active interrogation are commercially available in relatively inexpensive, compact units (e.g., D–T neutron generators, ^{252}Cf, $^{238}PuLi$ and other radioactive sources) which provide the required intensity and reliability for practical assay applications. Other assay signatures under investigation include prompt neutrons and gamma rays and delayed gamma rays produced by various interrogation sources. Assay results obtained using sub-threshold neutrons produced by a Van de Graaff accelerator together with prompt fission neutron detection are presented. New techniques utilizing neutron interrogation and fission neutron detection are being studied for spent fuel assay applications. Appropriate experiments and calculations show promise for determining the fissile content of hot, "spent" reactor fuel elements enclosed in lead shielding casks. For many plutonium-bearing samples, absolute quantities of ^{239}Pu, ^{240}Pu, and ^{241}Pu can be determined by measuring the characteristic gamma rays and neutrons emitted in the natural radioactive decay of these isotopes. Application of high-efficiency, high-resolution Ge(Li) gamma-ray detectors and high efficiency neutron detectors (integral and coincidence) has greatly advanced the utility of passive assay methods. Practical implementation of passive assay techniques together with those factors which limit the ultimate accuracy of passive assay will be discussed. (auth)

20937 APPLICATION AREAS AND RESULTS OF NON-DESTRUCTIVE ASSAY MEASUREMENTS. Keepin, G. R.; Menlove, H. O.; Thorpe, M. M.; (and others) (Los Alamos Scientific Lab., N. Mex.). pp 79-112 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

The nondestructive techniques for active and passive assay of fissionable materials described in the companion paper by Augustson, et al. (these Proceedings) were applied to sample materials varying widely in physical and chemical form, composition, and geometry. The materials analyzed are typical of those found in the nuclear industry and assay data will be reported in three major categories associated with the nuclear fuel cycle: reactor fuels, inventory verification samples, and fissionable material scrap. These assay results serve both to illustrate the practical capabilities of nondestructive assay techniques and to indicate typical assay accuracies which can be anticipated for a given type of sample. Results reported include active assay data obtained using delayed-neutron response methods, the neutron self-indication method, sub-threshold neutron interrogation with prompt and delayed neutron response, and complementary neutron-induced gamma ray signatures. Assay measurements using high-resolution high-efficiency gamma ray detectors and high-efficiency, flat-response neutron detectors (both coincidence and "singles" counting modes) are reported for various sample compositions and configurations ranging from small (few cm^2) vials to 55-gal drums. Some representative comparisons of passive versus active assay results are presented for reactor fuel materials, finished reactor fuel elements, safeguards inventory verification samples, and fissionable scrap materials. Quantitative nondestructive assay of individual fission

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isotopes in unknown samples and finished product items are reported with assay accuracies ranging from less than 0.5% to several per cent or greater depending upon the composition, quantity, and geometry of the sample or item being interrogated. (auth)

20938 APPLICATION OF INSTRUMENTAL METHODS TO THE DETERMINATION OF NUCLEAR FUEL MATERIALS FOR SAFEGUARDS. Brown, F. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Terrey, D. R.; Hornsby, J. B.; (and others). pp 125-42 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

It is generally accepted that the burden of inspection will be reduced significantly by the use of nondestructive techniques, preferably as portable instruments; promising techniques have already been described. Current problem areas and five means for their resolution are discussed. (1) Delayed neutron counting following fast fission: This method can be applied to fuel materials in a range of sizes, shapes and physical forms since the 14-MeV neutrons used for irradiation penetrate well into all materials. Calibration with suitable standards is required. The identity of the material under investigation can be established by analysis of the delayed neutron decay curve. The method is especially valuable for the measurement of swarf, slags, heterogeneous scrap, and other materials which require recycle and present difficulties to conventional sampling techniques. (2) Gamma absorptiometry: This technique is being developed primarily for the on-line measurement of fuel material concentration in plant solutions where problems of inhomogeneity and non-representative sampling cause difficulties with normal procedures. A prototype modulated beam gamma absorptiometer has been constructed which removes almost entirely any interference from the gamma activity of the fuel itself. The method is also used for solid fuel materials, e.g., MTR-type uranium alloys. (3) Coulometry: This method has been developed for the determination of plutonium and uranium in samples of plant solutions. A portable battery-operated constant current coulometer has been designed and built for use at the 50 to 100 μg level. For higher levels controlled potential coulometry is the preferred technique and a portable instrument having both constant current and controlled potential facilities is under development. This technique is very promising for use by inspectors at reprocessing plants where rapid checks on plant solutions would be extremely valuable. (4) Fission neutron counting: This method, in which neutrons of spontaneous fission origin are distinguished from others, is being developed for use in portable instrumentation for plutonium-containing fuels and has been used extremely effectively in inspection of fuel stocks at a large zero-energy reactor facility (ZEBRA) in the UK. (5) Gamma-spectrometry: This technique is applicable when a suitable gamma ray of characteristic energy is emitted (e.g., ^{235}U, 185 keV; ^{239}Pu, 384 keV; certain fission products in irradiated fuel). Its usefulness is limited by self-absorption and geometrical considerations but it is valuable for discards monitoring (for which a drum scanner is available) and for small samples of fixed geometry. Two patterns of portable instruments are available and a portable gamma-counting jig has been designed. As with fission neutron counting, this technique has proved of great value in the inspection of the ZEBRA fuel inventory. (auth)

20939 NEW DEVELOPMENTS IN NUCLEAR MATERIAL ASSAY USING PHOTONUCLEAR REACTIONS. Gozani, T.; Rundquist, D. E.; Ginaven, R. O.; Bramblett, R. L. (Gulf General Atomic Inc., San Diego, Calif.). pp 143-63 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

New techniques, based on photoneutron production from a small electron LINAC, have been developed for specific applications to measure the amount of fissile material in the presence of vast amounts of fertile material. One method, which also demonstrates the versatility of a LINAC as a powerful tool for nondestructive assay, is based on the production of neutrons by the D(γ,n) reaction. Electron beams with energy below about 4.5 MeV can produce an intense source of neutrons with energies below 1 MeV. These neutrons produce fissions only in the fissile materials present, irrespective (apart from the attenuation) of the presence of fertile or inert (e.g. iron) materials. The amount of the fertile material can be determined by increasing the electron energy. The LINAC sub-MeV technique has been applied successfully to various metallic samples with a high ratio of ^{238}U to ^{235}U. A careful sensitivity study was made by measuring the amount of ^{235}U in a sample (~60 g) of depleted uranium oxide. A second technique, which takes full advantage of the high instantaneous neutron intensities (and their variable energy spectrum) created by a LINAC, is the Neutron Timing Sub-MeV (NTSM) technique. This method makes use of the early time high-intensity sub-MeV neutron fluxes achieved in a pulsed assembly made of heavy moderator. This feature in conjunction with a LINAC results in very high sensitivity towards fissile materials. A third photoneutron-based technique was developed for cases where the neutron intensity and versatility of the first method is not required. This method is based on the (γ,n) reaction in beryllium from the 1.70 MeV gamma line of an antimony source, which yields relatively low-energy (30-keV) neutrons. This simple method is very useful in assaying fixed-geometry samples such as fuel rods. This new method was applied successfully to various samples including metal fuel plates and HTGR fuel sticks. Using the present model assembly a sensitivity of about 3 to 10 counts/s per gram ^{235}U is obtained. A modification of the last method has been introduced, based on a higher energy neutron source. This method allows also for the determination of the fertile material content using the multiplicity of the fission neutrons. Another powerful technique which has been applied is to detect gamma rays following photofission. The gamma spectrum taken during a time period following an irradiation uniquely identifies the presence of fissionable material and can also discriminate between the isotopes undergoing fission. The isotopic discrimination arises from the dependence of the fission product yield on the fissioning isotope. To resolve the complex fission-product gamma-ray spectrum a large high-resolution lithium-drifted germanium detector has been used to measure the photofission gamma spectra of ^{232}Th, ^{235}U, ^{238}U, and ^{239}Pu in 1-min intervals from one minute up to several hours after a bremsstrahlung irradiation. Prominent lines have been seen in all cases, including several lines which have energies near or above 1 MeV. These higher-energy gamma lines can penetrate materials much further than gamma rays following the natural radioactive decay of the fissile isotopes. This results in an assay which is nearer to uniform sensitivity over the entire sample volume. (auth)

20940 PLUTONIUM AND AMERICIUM MEASUREMENT IN HUMANS BY X- AND GAMMA-RAY SPECTRAL ANALYSIS. Yaniv, Shlomo Stefan. Pittsburgh; Univ. of Pittsburgh (1969). 194p. University Microfilms Order No. 70-17,069.

Thesis.

For efficient medical management of plutonium-contaminated patients, a method capable of rapid detection and measurement of the contaminant is highly desired. Body burden measurements based on excretion analysis are not always adequate, and the results are not easily available in the short post-exposure period, when most needed. As a result of the low energy and low abundance of electromagnetic radiation emitted by ^{239}Pu, detection of in vivo ^{239}Pu by external measurements is difficult. Body burden measurements are further complicated by the fact that in most practical cases the contaminant is composed of several plutonium isotopes and ^{241}Am. The interactions of relevant x and γ rays with human tissues and detector materials are analyzed and the development of a method that permits, in principle, the evaluation of plutonium–americium body burdens is described. This method utilizes the measurements of electromagnetic radiation emitted by these isotopes, without requiring the a priori knowledge of Pu-to-Am ratio, or excreta analyses. The method is based on analyses of spectral distributions of radiation emanating from plutonium and americium. The spectra were obtained using a xenon-filled proportional counter. The interactions of plutonium and americium L x rays and americium 60-KeV γ rays, with the xenon-filled proportional counter were investigated, and the effect of the escape from the counter of characteristic x rays of xenon on the observed spectrum is evaluated. Mathematical relationships, based on theoretical considerations and experimental data, relating the observed spectra to plutonium and americium body content were developed. A computer program to calculate the body content was derived and is presented. Statistical limitations of the count procedure confine the described method to point sources of plutonium–americium mixtures in which at least 2% of the α activity is due to americium activity, and to cases in which there is no significant internal contamination by radioisotopes other than those of plutonium and americium. In cases of contamination by essentially pure plutonium the problem is simpler, since there are no ^{241}Am L x rays, nor are there problems associated with the escape of the characteristic x rays. Experimental tests, using a human phantom, also indicate that the method can be used for measurements of plutonium–americium mixtures located in soft tissues up to a depth of not more than about 4 cm. Suggestions for extension of the method to other source distributions and greater depths are presented. (Diss. Abstr.)

XUM

20941 QUANTITATIVE DETERMINATION OF ^{60}Co IN THE COOLING WATER OF THE VVR-S REACTOR OF THE INSTITUTE OF ATOMIC PHYSICS. Alexan, Zamfira; Ionescu, Ecaterina (Inst of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 22: 677-83(1970). (In Rumanian).

The polarographic method as well as the complexometric method used for ^{60}Co determination in the cooling water of a reactor are more difficult to apply for this determination, as they require a series of auxiliary operations that increase the analyzing time and reduce the precision of measurements due to the losses of Co, that may occur during the separation of Co from Ni. For this reason the radiometric method was checked for quantitative determinations. The radiometric method applied to determination of ^{60}Co in the cooling water of the VVR-S reactor, was based on relative measurements, using calibrated sources, whose activity was compared with the activity of the samples to be measured, using gamma spectrometry. The methods presented may also be used for quantitative determination of ^{60}Co in alloys. (auth)

20942 RAPID SEPARATION OF RUTHENIUM FROM THE FISSION PRODUCTS OF URANIUM. Riccato, M. T. (Univ., Mainz). Radiochim. Acta; 15: 3-7(Jan 1971). (In German).

The detection of short-lived nuclides in a mixture of fission products requires a fast and selective separation procedure with well-reproducible chemical yields. The best results for Ru are obtained when the solution of the uranium in perchloric acid (70%) containing sodium chlorate is distilled at a temperature of about 150°C in a stream of air. Counting of the distillate is started usually 55 sec after the end of irradiation. The time requirement for the distillation itself is about 5 sec. The chemical yield of this fast separation was approximately 50% of the amount found in the trap after a 4 min distillation time by counting long-lived Ru isotopes. The γ rays of the Ru and Rh isotopes 103, 105, 107, and 108 are confirmed. A few previously unknown γ rays are attributed to nuclides with half-lives of approximately 20, 40, and 60 to 120 sec. The half-life of ^{103}Ru was confirmed to be 35 sec by counting the daughter products after chemical separation of Pd. In the separation of Pd two further half-lives were measured indicating a Ru isotope with a half-life of 1 to 2 min which, presumably, can be attributed to chain 111. (auth)

20943 DETERMINATION OF ^{137}Cs IN MILK. Wiechen, Arnold (Institut fuer Physik, Kiel). Milchwissenschaft; 24: 669-72(1969). (In German).

The ^{137}Cs activity is separated by chemical means and measured with a single-channel spectrometer with a well-type NaI(Tl) crystal or with a γ-spectrometer. A complete separation of Ca and a ≃98% yield of ^{137}Cs were obtained. Determinations were made on 6 samples of ash in 2 to 3 hr. The maximum error of the determination was ≃5%, which corresponds to an error of <10 pCi per liter of milk. (TSS) (Anal. Abstr.)

20944 RADIOMETRIC DETERMINATION OF URANIUM IN THE PRESENCE OF IRON. Matous, K.; Tomik, B. (Inst. of Mining and Metallurgy, Ostrava, Czech.). Hutn. Listy; 24: 882-5(Dec 1969). (In Czech).

The radiometric determination of U in the presence of Fe in alloys containing from 0.15 to 15% of U was studied. After dissolving the alloy in 20 ml of concentrated sulfuric acid and 5 ml of nitric acid, the solution was evaporated and quantitatively transported to a 25-ml volumetric flask. Beta and gamma activities were directly determined in constant geometry using a GM tube. For calibration, pure standard solutions of metallic U were used with addition of Fe amounts corresponding to those expected in the samples. The results were evaluated statistically and compared with chemical analyses. Good agreement between both methods was found, especially at U concentrations exceeding 1%. (NSA of Czech)

Activation Procedures

Refer also to abstracts 21064, 21076, 21658, and 22057.

20945 (ANL-7760(Pt.2), pp 47-52) THORIUM AND URANIUM IN BLOOD, URINE, AND CIGARETTES. Lucas, H. F. Jr.; Markun, Francis (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969-June 1970.

The analytical method previously developed for thorium in bone was modified to remove interference from sodium and bromine. The thorium in the red cell fraction of blood was 0.17 ppB, which was at least 4 times that for plasma. The uranium content was less than 0.4 ppB in both blood and urine. Thorium in urine ranged from 0.2 to 5 ppB but was detectable in only one half of the samples. Both the thorium and uranium content were 0.15 μg/cigarette or 3 μg/pack. (auth)

20946 (GA-9829) SPECIAL REPORT ON GUNSHOT RESIDUES MEASURED BY NEUTRON ACTIVATION ANALYSIS. Schlesinger, H. L.; Lukens, H. R.; Guinn, V. P.; Hackleman, R. P.; Korts, R. F. (Gulf General Atomic, Inc., San Diego, Calif.). 10 Aug 1970. Contract AT(04-3)-167. 144p. Dep. NTIS.

Studies which aid in an accurate interpretation of results of neutron activation analysis of residue material removed from the back of a gunhand are reported. Data are presented on large-scale statistical studies of gunshot residues from revolvers and automatic pistols of various common calibers, and of Ba and Sb present on the hands of persons, of various occupations, who had not recently fired a gun (occupational handblanks). Concurrently, a suitable statistical method for the interpretation of such Ba-Sb data was developed: the bivariate-normal (BVN) method—actually a bivariate log-normal treatment. The development of the BVN method, its application to the accumulated Ba-Sb data, and its potential use in the interpretation of actual criminal-case results are also presented. It is shown that, in most instances, Ba-Sb results, properly obtained and properly interpreted, can provide a fairly definitive distinction between a hand that has recently fired a handgun and one that has not (or one that has subsequently been washed clean before being sampled). (J.G.B.)

20947 (GA-10113) FORENSIC NEUTRON ACTIVATION ANALYSIS OF PAPER. Lukens, H. R.; Schlesinger, H. L.; Settle, D. M.; Guinn, V. P. (Gulf General Atomic, Inc., San Diego, Calif.). 22 May 1970. Contract AT(04-3)-167. 50p. Dep. NTIS.

Neutron activation analysis (NAA) was implemented with a nuclear reactor and multichannel gamma spectrometer to examine the elemental "fingerprints" of papers and inks. Preliminary studies showed that while a number of elements could be measured in paper by NAA, these elements completely interfered with the measurement of elements in ink printed on paper. Study of 120 papers from 40 different "batches" of paper showed that the use of NAA for meaningful comparison of two or more samples of paper is feasible, and that the method could be brought to an advanced stage of forensic implementation with a larger data base. (auth)

20948 (GA-10141) FORENSIC NEUTRON ACTIVATION ANALYSIS OF BULLET-LEAD SPECIMENS. Lukens, H. R.; Schlesinger, H. L.; Guinn, V. P.; Hackleman, R. P. (Gulf General Atomic, Inc., San Diego, Calif.). 20 Jun 1970. Contract AT(04-3)-167. 48p. Dep. NTIS.

The possibility of using instrumental neutron activation analysis to determine whether two bullet lead specimens have common or different sources was examined. It has been found that the number of elements observable, and thus the number of points of comparison, is generally limited to three elements, because of dominance of antimony radioisotopes in the activated bullet lead specimens. This factor, coupled with a high degree of composition uniformity of bullet lead from at least one major manufacturer, imposes some limitations on the method. Thus, while differences in identification points definitively indicate a difference in sources, two bullets with the same pattern of only three identification points are not usually definitively identified as having a common source. Recommendations are given with respect to extending the activation analysis technique to enable positive identification of bullet samples as being from common or different sources. (auth)

20949 (N-70-42813) LOW-ENERGY ACTIVATION ANALYSIS FOR GEOCHEMICAL EXPLORATION. Ferguson, George A. (Howard Univ., Washington, D. C.). 1 Aug 1970. 19p. (NASA-CR-110888). NTIS.

Research is reported in a program to obtain pulse height spectra using radioisotopic calibration sources and monochromatic radiation produced by a bent crystal spectrometer. Descriptions are given for the methodology and instrumentation employed in the research. The experimental results are detailed and their significance analyzed. (STAR)

20950 (ORO-3922-2) RESEARCH IN CHARGED PARTICLE ACTIVATION ANALYSIS. Progress Report, February 1, 1970-January 31, 1971. Schweikert, E. A. (Texas Agricultural and Mechanical Univ., College Station. Research Foundation). 29 Jan 1971. Contract AT(40-1)-3922. 66p. Dep. NTIS.

Possible interfering reactions in the α, deuteron, and helium-3 activation determination of carbon were surveyed. Sub-ppM C determinations were carried out on high-purity Si. Detailed activation

curves were obtained for deuteron- and proton-induced reactions in the determination of S and Cl. Studies were continued on the development of a technique for probing impurity distribution in samples using a beam of varying energy. An activation curve for $^{12}C(d,n)^{13}N$ was established using mylar foils irradiated with a beam diffusing through the foil in different positions. Preliminary tests on impurity distributions were run with a beam of 10-MeV protons using the reaction $^{12}C(p,p')^{12}C^*$ and measuring the 4.4-MeV γ ray. Studies were initiated on activation methods for the production of short-lived radioisotopes to be used for on-line detection of impurities. Preliminary work is underway on defining experimental conditions for the exploitation of inelastic scattering reactions using protons up to 10 MeV. (J.G.B.)

20951 SIMPLE LIQUID SCINTILLATION COUNTING OF TRITIUM INCORPORATED IN MOUSE BONE MARROW. Heiniger, H. J. (Kernforschungsanlage, Juelich, Ger.); Giesen, L.; Feinendegen, L. E. Naturwissenschaften; 57: 674(Dec 1970).

A procedure using Soluene is described for counting tritium incorporation in bone marrow cells. Soluene treatment of whole bones leads to labilization of tracer into the liquid scintillation medium. The technique is compared to the usual method using Hyamine for sample digestion and shows the counting efficiency to be comparable. (D.P.O.)

20952 ANALYTICAL USE OF SHORT-LIVED NUCLIDES FROM (n,n') REACTIONS FOR DETERMINATION OF YTTRIUM AND LEAD. Henkelmann, R.; Pfeffermann, E.; Born, H.-J.; Aumann, D. C. (Technische Univ., Garching, Ger.). Radiochem. Radioanal. Lett.; 6: 21-30(10 Feb 1971). (In German).

A rapid and nondestructive method for the determination of yttrium and lead by fast neutron inelastic scattering induced nuclides ^{89m}Y and ^{207m}Pb is described. The procedure consists of irradiating samples and standards in a fast rabbit system in a fast neutron position of the Munich research reactor. The detection limit for yttrium is about 0.5 μg and for lead about 200 μg. (auth)

20953 URANIUM: FURTHER INVESTIGATION OF URANIUM CONTENT OF CARIBBEAN CORES P6304-8 AND P6304-9. Mo, Tin; O'Brien, Barbara C.; Suttle, A. D. Jr. (Texas A and M Univ., College Station). Earth Planet. Sci. Lett.; 10: 175-8(Jan 1971).

Uranium content in P6304-8 and P6304-9 Caribbean cores is determined by thermal neutron activation followed by delayed neutron counting and ^{132}Te fission product radiochemistry. The average value obtained by these two methods is 34% higher than that obtained previously by alpha spectrometry. (auth)

20954 DETERMINATION OF OXYGEN IN METALLIC COPPER BY 14 MeV NEUTRON ACTIVATION ANALYSIS. Taczanowski, S.; Janczyszyn, J. (Inst. of Nuclear Techniques, Krakow). Radiochem. Radioanal. Lett.; 6: 101-7(2 Mar 1971).

Copper standards containing oxygen, which allowed self-absorption and self-shielding to be neglected were prepared. The influence of the copper activity on the accuracy of analysis was tested. No containers were used, hence a low blank value was obtained. The determination limit estimated for 33% relative standard deviation is 4 ppM. (auth)

20955 DETERMINATION OF TOTAL NEUTRON OUTPUT FROM TITANIUM TRITIDE TARGETS. Bibby, D. M.; Oldham, G. (Loughborough Univ. of Tech., Eng.). Radiochem. Radioanal. Lett.; 6: 109-13(2 Mar 1971).

A method was devised for measuring the total neutron output of a neutron generator target by measurement of the ^{60}Co activity produced in the copper backing. (auth)

20956 SPONTANEOUS ANALYSIS IN METALLURGY BY USE OF THE PROMPT (n,γ) PROCESSES. Higatsberger, M. J. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Radex Rundsch.; No. 3, 182-90(1970). (In German).

Tolerances and measuring times of present methods of analysis in the steel manufacturing cycle are compared with prompt (n,γ) methods, neutron activation analysis, and photoactivation. The use of prompt (n,γ) processes for analyses of melts in the converter, reactions of fast neutrons in the pure iron bath, experimental arrangement of the Ge(Li) spectrometer-detector pair, and experimental results are discussed. (auth)

20957 USE OF COUNTERCURRENT ELECTROLYSIS AS A SEPARATION METHOD IN ACTIVATION ANALYSIS. Behne, D. (Hahn-Meitner Inst., Berlin). Radiochem. Radioanal. Lett.; 6: 39-43(10 Feb 1971).

An electrochemical, one-step group separation for the activation analysis of multielement materials is described. For the remotely controlled processing of highly active samples a simple apparatus was designed. (auth)

20958 INSTRUMENTAL ACTIVATION ANALYSIS OF 11 LANTHANIDE ELEMENTS IN APOLLO 12 LUNAR SAMPLES. Rosenberg, J.; Wiik, H. B. (Helsinki Univ. of Tech.). Radiochem. Radioanal. Lett.; 6: 45-55(10 Feb 1971).

A method for determining 11 lanthanides, viz., La, Ce, Nd, Sm, Eu, Gd, Tb, Dy, Tm, Yb, and Lu in silicate rocks by thermal neutron irradiation and direct γ counting is described. The measurements are performed by means of two Ge(Li) detectors, one 30 cm^3 coaxial and one 0.44 cm^3 planar high resolution detector. Results for the Apollo 12 lunar samples 12052 and 12065 and the Apollo 11 samples 10084 and partly 10017 are reported. W-1 is used as standard. (auth)

20959 NEUTRON ACTIVATION ANALYSIS OF WHEAT FLOUR SAMPLES. Nadkarni, R. A.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Radiochem. Radioanal. Lett.; 6: 89-96(10 Feb 1971).

Fourteen trace elements were determined in two wheat flour samples supplied by I.A.E.A. and in two U. S. commercial flour samples, by nondestructive activation analysis using a high resolution Ge(Li) detector. Of the two I.A.E.A. samples, one was treated with Hg and the other was untreated. The results obtained for Hg are in good agreement with the recommended values given by I.A.E.A. The elements determined, other than Hg, were Fe, Zn, Br, Ag, Cr, As, Se, La, Co, Sc, Sb, Cs, and Eu. (auth)

20960 DETERMINATION OF TRACE ELEMENTS IN TEA PLANT BY NEUTRON ACTIVATION ANALYSIS. Takeo, Tadakazu (Ministry of Agriculture and Forestry, Shizuoka, Japan); Shibuya, Masao. Radioisotopes (Tokyo); 20: 25-8(Jan 1971).

The application of activation analysis to the determination of trace elements in the tea plant was investigated, and results for the elemental concentrations of Mn, Cu, K, Na, Zn, and Br in different parts of tea plants are compared. Analyses of Japanese green and black teas are compared with those from other countries. The sodium content of the Japanese teas is considerably higher than that in teas from the other countries. (J.G.B.)

20961 TISSUE COPPER, ZINC, AND MANGANESE LEVELS IN WILSON'S DISEASE: STUDIES WITH THE USE OF NEUTRON ACTIVATION ANALYSIS. Leu, Mei Ling; Strickland, G. Thomas; Yeh, S. J. J. Lab. Clin. Med.; 77: 438-44(Mar 1971).

Copper, zinc, and manganese were determined by neutron activation analysis on tissues obtained at autopsy from 3 patients with Wilson's disease and 2 patients who died from other causes. Tissues from the latter 2 served as controls. The mean copper concentration in the brain and liver of the 3 patients with Wilson's disease was 9 to 30 times greater than that of the 2 controls. The copper concentration in the other tissues studied from 2 patients who had received penicillamine therapy for 12 to 14 months was only slightly higher than the values from the controls. The patient who did not receive penicillamine therapy had marked elevations in copper concentration in all tissues studied. Zinc and manganese tissue concentrations did not differ appreciably between patients and controls. These data suggest that penicillamine therapy results in a reduction of the tissue copper as follows: (1) most rapidly from the kidney, (2) more slowly from the liver and other selected tissues in this study, and (3) slowest from the central nervous system. The very high concentration of splenic and muscle copper in the untreated patient suggests that she was supersaturated with copper. (auth)

20962 METHOD FOR AUTOMATIC ANALYSIS OF GAMMA-RAY SPECTRA AND ITS APPLICATION TO ACTIVATION ANALYSIS. Takeuchi, Takayuki; Hayashi, Takeo (Kyoto Univ.) Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 9-18(1970).

A computer method is described that permits automatic analysis of gamma spectra measured with lithium drifted germanium detectors. The limit of peak searching is given in connection with the peak amplitudes and widths. An available list of the representative gamma rays that connect the peak locations to the kinds of elements is presented for the Z = 11 ~ 92 elements. The applications of this list are shown for several elements. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 21076, 21083, and 22145.

XUM

Chemical Properties

Refer also to abstracts 21084, 21111, 21147, and 21148.

20963 (CONF-700816-(Vol.2), pp 467-81) HYPOIODOUS ACID: AN AIRBORNE INORGANIC IODINE SPECIES IN STEAM–AIR MIXTURES. Keller, J. H.; Duce, F. A.; Pence, D. T.; Maeck, W. J. (Idaho Nuclear Corp., Idaho Falls).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

Hypoiodous acid was first postulated by this laboratory (in early 1968) to exist as an airborne species of iodine. It has an airborne half-time on the order of a day, is the major airborne inorganic iodine species after the initial washout of elemental iodine from a steam–air atmosphere, and is not easily removed by sprays. Airborne hypoiodous acid is generated by the injection of elemental iodine into a steam–air atmosphere or by purging a dilute aqueous solution of iodine in water with air or other gases. Hypoiodous acid was prepared in solution by the reaction $I_2 + H_2O + HgO \rightarrow 2HOI + HgI_2$ and confirmed by a specific chemical reaction. The heated solution was purged with air into a cold trap where hypoiodous acid was again detected by the specific chemical reaction. Further, chemical tests for elemental iodine and species with oxidation states higher than hypoiodous acid were negative for the volatile fraction. The equilibria concerned with the hydrolysis of iodine are discussed to show that hypoiodous acid is a major species in solution. Relationships are given for the ratio of hypoiodous acid to total iodine in solution as a function of pH and temperature. In a water-cooled power reactor, the accident-released fission products will contact a heated water solution at a pH of 7 to 10 and then will transport to a steam–air atmosphere. These conditions seem ideal for the formation and stable existence of hypoiodous acid in the vapor state. Thus, it, rather than methyl iodide, could well be the hazardous species from the biological standpoint. Hypoiodous acid, like methyl iodide, penetrates various adsorbents including silver surfaces commonly used in atmospheric samplers and thus may explain the abnormally high organic fractions reported by other investigators. Hypoiodous acid is important to the spray technology program because its removal rate differs from that of elemental iodine and methyl iodide. (auth)

20964 (CONF-700816-(Vol.2), pp 600-6) ANALYSIS OF CONCURRENT ADSORPTION AND CHEMICAL REACTION IN PACKED BEDS. Underhill, Dwight W. (Harvard School of Public Health, Boston, Mass.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

A series of equations were developed to describe accurately concurrent adsorption and chemical reaction of gases in packed granular beds. These equations use analysis by statistical moments to develop a straightforward, rapid method for calculating breakthrough curves. A useful feature of these equations is that they provide a method for calculating the fraction of adsorbate that will pass through the bed unreacted. (auth)

20965 (KFK-1068) COMPLEX FORMATION OF PENTA- AND HEXAVALENT ACTINIDES WITH HETEROCYCLIC CARBOXYLIC ACIDS. Brandau, Egbert (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Oct 1970. 92p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Karlsruhe, Ger.

Complexing of the actinide ions UO_2^{2+}, NpO_2^{2+}, PuO_2^{2+}, and NpO_2^{+} was investigated preparatively and in solution with heterocyclic carboxylic acids (S, O, N-hetero atoms). The following types of compounds are obtained: ML_2, $ML_2 \cdot H_2O$, AML_3 ($A = Na^+, NH_4^+$), $M_2L_3(OH) \cdot 4H_2O$, and $ML \cdot H_2O$. The equilibra in solution showed 1 : 1 and 1 : 2 complexes and, for the N-heterocyclic acids, hydrogen complexes in addition to the normal ones. The stability constants were calculated from potentiometric and spectrophotometric data using programs for computer calculation. Infrared and thermogravimetric investigations of the solid compounds showed that 2-pyridinecarboxylic acid and its N-oxide formed a real chelate. For oxygen and sulfur hetero atoms (furoic acid and thiophenic acid) only weak complexing was found. The hydrolysis of hexavalent plutonium was investigated also and showed a monomeric 1 : 1 followed by 1 : 2 hydrolysis (pH ≃ 6,5). (auth)

20966 (SRO-645-1) PHOTOELECTRON SPECTROSCOPY. Progress Report, Fiscal Year 1970-71. Hercules, David M. (Georgia Univ., Athens. Dept. of Chemistry). Contract AT-(38-1)-645. 17p. Dep. NTIS.

Research progress is reported on computerization of the magnetic spectrometer, a cryogenic probe, oxidation states of Mo compounds and compounds of Group VI elements, protonation sites, phosphonitrilic trimers, and ESCA spectra of metal chelates, including Na, Zn, Ag, Ba, Hg, La, Ni, and Th. (M.C.G.)

20967 METAL-BINDING ABILITIES OF RADIOPROTECTIVE ORGANIC THIOSULFATES. Foye, William O.; Kim, Choon Mi (Massachusetts Coll. of Pharmacy, Boston). 60: 151-3(Jan 1971).

Ionization constants and stability constants for the complexation of Cu(II), Al(III), and Fe(III) ions by several aminoalkane and cyanoalkane thiosulfates were determined. Metal-binding avidities of the aminoalkane thiosulfates were found to be significantly less than those for the amino (or guanidino) thiols or for dithiocarbamates having radioprotective properties, but the possibility exists that organic thiosulfates may stabilize cuprous ion-containing macromolecules against radiation damage. (auth)

20968 HYDROGEN AND METAL COMPLEXES OF SOME 3-CYANOFORMAZANS. Budesinsky, B. W.; Svec, J. (Univ. of Waterloo, Ont.). Inorg. Chem.; 10: 313-17(Feb 1971).

1,5-Bis(2-hydroxyphenyl) (I), 1,5-bis(2-hydroxy-4-nitrophenyl) (II), 1,5-bis(2-hydroxy-5-sulfophenyl) (III), 1,5-bis(2-carboxyphenyl) (IV), 1,5-bis(2-arsonophenyl) (V), 1,5-bis(8-quinolyl) (VI), 1,5-bis(8-quinaldyl) (VII), and 1,5-bis(4-anti-pyrinyl) (VIII) derivatives of 3-cyanoformazan were prepared and their hydrogen and metal complexes were investigated. The investigation involved the following metals: calcium, scandium, lanthanum, thorium, vanadium(V), molybdenum(VI), manganese(II), iron(II), iron(III), cobalt(II), nickel, copper(II), palladium(II), zinc, cadmium, mercury(II), lead(II), and bismuth. Complex ZnH_2L of compound VI and complexes CuL and PdL of compound VIII are of unusual stability. The values of logarithmic overall stability constants are 32.4, 28.2, and 28.1, respectively. (auth)

20969 SPECTROPHOTOMETRIC INVESTIGATION OF NITRATE, CHLORIDE, AND BROMIDE COMPLEXES OF THE URANYL ION IN ACETONE SOLUTIONS. Poluektov, N. S.; Burtnenko, L. M. Radiokhimiya; 12: 607-11(1970). (In Russian).

It was found spectrophotometrically that in acetone solutions of uranyl ions the formation of the complex ion $[UO_2(NO_3)_3]^-$ occurs when nitrates of a number of amines not investigated previously, as well as lithium and calcium nitrates, are added. It was established that complexes with Cl^- and Br^- are formed by the uranyl ion in acetone solutions even when the acids HCl and HBr themselves are added, as a result of their greater dissociation in comparison with HNO_3. The existence of the particles UO_2Cl^+, UO_2Cl_2, $[UO_2Cl_3]^-$, $[UO_2Cl_4]^{2-}$, and in the case of bromide complexes UO_2Br_2, $[UO_2Br_3]^-$, and $[UO_2Br_4]^{2-}$, was established. (tr-auth)

20970 EXPERIMENTS ON THE CHEMISTRY OF ELEMENT 104: KURCHATOVIUM. V. ADSORPTION OF KURCHATOVIUM CHLORIDE FROM A GAS STREAM ON THE SURFACE OF GLASS AND POTASSIUM CHLORIDE. Zvara, I.; Chuburkov, Yu. T.; Belov, V. Z.; (and others). Radiokhimiya; 12: 565-72 (1970). (In Russian).

The adsorption of kurchatovium chloride was studied at 300 to 305°C from a gaseous mixture of chloride compounds on glass and on KCl crystals. For comparison the behavior of chlorides of fermium, californium, curium, americium, plutonium, scandium, and sodium was followed simultaneously. In experiments with labeled atoms on experimental apparatuses not connected with an accelerator, the adsorption of chlorides of a number of other elements under analogous physicochemical conditions was determined. It was confirmed that kurchatovium forms a chloride $KuCl_4$, with properties close to those of the chloride $HfCl_4$, and, consequently, is an analog of hafnium and zirconium, i.e., a member of subgroup IVb of D. I. Mendeleev's Periodic System. The aggregate of data of this and our previous studies is experimental evidence that the fact that the family of 5f-elements ends at element 103, just as the 4f family ends at lutetium, and that Period VII of the Mendeleev system has a structure analogous to the structure of Period VI. Evidently kurchatovium chloride is somewhat less volatile than hafnium chloride, whereas $ZrCl_4$ and $HfCl_4$ differ very little. If this is so, then this indicates a weaker f-compression in Period VII, which is an important consideration in the chemical identification of the elements that follow. (tr-auth)

20971 ATTEMPT TO APPLY A TRACER TECHNIQUE FOR THE KINETIC STUDY OF THE OXIDATION OF Am(III). Ohyoshi, A.; Jyo, A.; Shinohara, T.; Ohyoshi, E. (Kumamoto Univ., Japan). Radiochem. Radioanal. Lett.; 6: 121-7(2 Mar 1971).

An attempt was made to apply the coprecipitation of Am(III) on lanthanum trifluoride for the kinetic study of the silver-catalyzed oxidation of Am(III) by ammonium peroxydisulfate. The results obtained by this method were compared with those by spectrophotometry. The fraction coprecipitated decreased with the reaction time and was in good agreement with that of Am(III) measured

spectrophotometrically. The reaction was found to obey first-order kinetics. It is shown that this method is available for the kinetic study of oxidation of Am(III). (auth)

20972 PREPARATION AND PHYSICOCHEMICAL STUDY OF URANYL GERMANATE. Legros, J. P.; Masdupuy, E. (Toulouse Univ.). Bull. Soc. Chim. Fr.; No. 12, 4297-4300(Dec 1970). (In French).

A uranyl germanate, which can be considered as a solid phase of the system $GaO_2-UO_3-H_2O$ was prepared by various methods. Its chemical composition corresponds to the formula $GeO_2 \cdot 2UO_3 \cdot 2H_2O$. Thermally stable up to 300°C, it decomposes at higher temperatures into germanium dioxide, uranium trioxide, and water. It crystallizes in the orthorhombic system and the unit cell, which belongs to the space group D_{2h}^{14}, contains 8 molecules. Its crystal parameters are a = 8.17$_9$ Å, b = 11.51$_5$ Å, and c = 19.39$_7$ Å, and its specific weight is 5.15 g/cm^3. The interpretation of its infrared spectrum is discussed. (France)

20973 PREPARATION OF ISOQUINUCLIDINE DERIVATIVES AND PRODUCTS OBTAINED BY APPLICATION OF THE PROCESS. Rassat, Andre; Rey, Paul (to Commissariat a l'Energie Atomique). French Patent 1,591,639. 4 May 1970. Filed 7 Oct 1968. (In French).

A method of preparation of isoquinuclidine derivatives for use as radiosensitizers is presented. Isoquinuclidine (indexed as 2-azabicyclo[2.2.2]octane) derivatives are obtained by the action of ammonia on a diethylene ketone, piperitenone. The compound obtained is 1,3,3-trimethyl-2-azabicyclo[2.2.2]octan-5-one. The nitroxide radical is obtained by the action of phosphotungstic acid and hydrogen peroxide on 1,3,3-trimethyl-2-azabicyclo[2.2.2]octan-5-one. The acetyl derivative is obtained by the action of acetic anhydride in pyridine on this compound. (France)

20974 EXISTENCE OF A URANYL MOLYBDIC COMPLEX. Burnel, Daniel (Nancy Univ.). Bull. Soc. Chim. Fr.; No. 11, 3781-6(Nov 1970). (In French).

The addition of uranyl nitrate to a solution of sodium molybdate gives a strong yellow solution with a pH near 7, in which the uranyl ions cannot occur in the free state. The salts $Na_2(UO_2 \cdot 2MoO_4) \cdot 6H_2O$ and $K_2(UO_2 \cdot 2MoO_4) \cdot 4H_2O$ were isolated. In solution, such salts behave as a complex of uranyl ions; this was demonstrated by colorimetry, polarography, and pH determination. From measurements of the change in absorption at 3,400 and 4,200 Å of a molybdate solution, maintained at constant pH (5.5) as a function of the addition of uranyl nitrate, a point corresponding to two molybdate ions for one uranyl ion was detected. The complex presents two well defined polarographic waves in the presence of an excess of molybdate (~0.55 and 1.25 V). The complex is very sensitive to changes in pH; it is stable at pH of about 5.5, but is transformed into uranate and molybdate in the presence of bases, or into uranyl molybdate and molybdic acid in the presence of acids. Its stability can be increased by the presence of an excess of molybdate. (France)

Isotope Effects and Exchange

Refer also to abstract 20926.

20975 (IS-T-403) LIGAND SUBSTITUTION REACTIONS OF PLATINUM(II) COMPLEXES. CHLORO(DIETHYLENETRIAMINE)PLATINUM(II)-CHLORIDE EXCHANGE. Paxson, John Ralph (Ames Lab., Iowa). Nov 1970. Contract W-7405-eng-82. 84p. Dep. NTIS.

Thesis.

Kinetics of the isotopic exchange of chloride in chloro(diethylenetriamine)platinum(II) chloride was studied using ^{36}Cl, employing an ion exchange quenching technique and activity determination by a liquid scintillation system. The equation equilibrium constant was determined by means of titrations of the acidic proton on the H_2O ligand formed according to the reaction: $[Pt(dien)Cl^+] + H_2O \rightleftharpoons [Pt(dien)H_2O^{2+}] + Cl^-$; K_{eq}. Titrations of the equilibrated solutions were performed over the range of 10^{-4} to 10^{-3} M complex concentrations at ionic strengths of 0.100 and 0.318 M for 25 and 35°C. For 25°C, μ = 0.100 M, $K_{eq} = 1.96 \times 10^{-4}$ M; μ = 0.318 M, $K_{eq} = 2.52 \times 10^{-4}$ M. For 35°C, μ = 0.100 M, $K_{eq} = 2.09 \times 10^{-4}$ M; μ = 0.318 M, $K_{eq} = 2.42 \times 10^{-4}$ M. The isotopic exchange followed the normal rate law for platinum(II) kinetics: Rate = $[k_1 + k_2 (X)]$Pt-complex. The exchange was studied over a twenty-fold range of chloride/complex ratios. At 25°C, μ = 0.100 M, $k_1 = 87.4 \pm 2.6 \times 10^{-6}$ sec^{-1}, $k_2 = 42.3 \pm 5.5 \times 10^{-5}$ M^{-1} sec^{-1}. For 35°C, μ = 0.100 M, $k_1 = 258.1 \pm 5.1 \times 10^{-6}$ sec^{-1}, $k_2 = 136.6 \pm 10.9 \times 10^{-5}$ M^{-1} sec^{-1}. The calculated activation parameters are $\Delta H^{\ddagger}_{aq} = 19.2 \pm 0.9$ kcal/mole, $\Delta S^{\ddagger}_{aq} = -12.8 \pm 3.1$ cal/mole deg; $\Delta H^{\ddagger}_{Cl} = 20.8 \pm 3.8$ kcal/mole, $\Delta S^{\ddagger}_{Cl} = -4.2 \pm 13.1$ cal/mole deg. (auth)

20976 KINETICS OF HETEROGENEOUS ISOTOPE EXCHANGE REACTIONS. Lieser, K. H. (Technische Univ., Darmstadt, Ger.). Monatsh. Chem.; 101: 1630-8(Nov-Dec 1970). (In German).

The partial steps of heterogeneous exchange reactions between a solid and a solution or gas phase are discussed, and corresponding rate equations given. The exchange reactions investigated so far between ion crystals and ions in solution are determined by the displacement reaction (2nd order reaction) at the surface. For the isotope exchange between sodium iodide and gaseous methyl iodide, desorption of methyl iodide at the surface is rate determining. In this reaction increasing temperature leads to the participation of more and more surface layers in the rapid surface exchange, while the activation energy for the exchange with the deeper lying layers rises continuously. (auth)

20977 SOLUBILITY OF RADON IN D_2O AND STRUCTURE OF AQUEOUS SOLUTIONS OF THE NOBLE GASES. Vdovenko, V. M.; Gurikov, Yu. B.; Legin, E. K. Radiokhimiya; 12: 670-3 (1970). (In Russian).

Studies on the role of structural factors in the behavior of aqueous solutions were continued. Radon was chosen for studies on isotope effects in the solubility of spherical nonpolar particles that exceed the dimensions of the ice-like framework of the structure of water. Radon was found to be more soluble in D_2O than in H_2O. Kinetic data point to the formation of gaseous hydrates in aqueous solutions of nonpolar particles. (J.G.B.)

20978 EXCHANGE OF ^{65}Zn BETWEEN ZnO(s) AND POTASSIUM ZINCATE. Vander Lugt, L. A.; Dirkse, T. P. (Calvin Coll., Grand Rapids, Mich). J. Electrochem. Soc.; 118: 265 (Feb 1971).

Studies of the system Zn/Zn(II), KOH, especially in concentrations ordinarily used in battery systems, have revealed certain anomalies that appear to be connected with the electrolyte phase. In order to more fully understand the electrochemical behavior of the system the rate of attainment of equilibrium between the electrolyte and the various solid phases using radioactive zinc isotopes was investigated. Some results of studies of the equilibrium between solid ZnO and the potassium zincate electrolyte are presented. The exchange of ^{65}Zn between the complex zincate ion and solid ZnO was studied by following the decrease in activity of the solution phase due to the uptake of ^{65}Zn by the ZnO. No significant exchange occurs over a period of 500 hr. The solid ZnO showed no radioactivity after the exchange study was terminated. During the saturation period, a small amount of exchange may occur, however, once saturation is achieved (~24 hr), no further exchange is evident. For zinc acetate the exchange process is normal. Decreasing pH increases the exchange rate by suppressing hydrolysis. (J.G.B.)

20979 EFFECT OF CATION ON THE EXCHANGE REACTION IN THE KETONIC PYROLYSIS OF MIXTURES OF ALIPHATIC CARBOXYLATES. Noszko, L.; Szabolcs, A.; Szammer, J. (Central Research Inst. for Chemistry, Budapest). Radiochem. Radioanal. Lett.; 6: 129-31(2 Mar 1971).

The isotopic tracer technique was applied to study the thermal exchange reaction between labeled and nonlabeled aliphatic acid salts. The specific radioactivity of the ketones obtained shows that the measure of exchange is determined by the character of the cation. (auth)

20980 ISOTOPE EFFECT MEASUREMENT BY DIFFUSION OF ^{55}Fe AND ^{59}Fe IN FERROUS OXIDE. Leroy, B.; Beranger, G.; Lacombe, P. (Ecole Nationale Superieure des Mines, Paris). Ann. Chim. (Paris); 5: 275-82(Jul-Aug 1970). (In French). (CONF-690350-1).

From Meeting on the Ferrous Oxide and Its Solid Solutions, Paris, France.

The coefficient E_β of the isotope effect was determined by diffusion of ^{55}Fe and ^{59}Fe in massive iron protoxide in equilibrium with a H_2-H_2O atmosphere. The isotope concentrations in the sample were measured from the activities recorded after grinding at different depths. The experimental results were processed by the mean square method using a computer. Some criterions were established to prove a posteriori the validity of the results. For a $Fe_{0.94}O$ sample annealed at 833°C, the relation $0.70 < E_\beta < 0.85$ was obtained, i.e., that $\Delta K = 1$ in the Claire's theory. (France)

20981 STUDIES ON THE DECOMPOSITION OF THE TETRAALKYLAMMONIUM SALTS IN SOLUTION. IV. THE α-DEUTERIUM SECONDARY ISOTOPE EFFECT. Ko, E. C. F.; Leffek, K. T. (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Chem.; 49: 129-32(1 Jan 1971).

The secondary deuterium isotope effect is reported for decomposition of benzyl-α-d_2-phenyldimethylammonium bromide in both chloroform and acetone solvent, over a temperature range of 25 to

XUM

30°C. The magnitudes of the rate ratios are compared to literature values for S_N1 reactions, from which it is concluded that the mechanism of the decomposition involves a carbonium ion or ion-pair. The variation of the isotope effect with solvent is rationalized in terms of specific solvent interaction with the benzyl group. (auth) (Canada)

20982 RESONANCE-COUPLING MODEL FOR SIMPLE MOLECULAR REACTIONS. McGuire, P.; Mueller, C. R. (Purdue Univ., Lafayette, Ind.). Phys. Rev., A; 3: 1358-66(Apr 1971).

A strong-coupling model for the simple exchange reaction A + BC → AB + C was developed by considering the atom-diatom inelastic problems A + BC and AB + C separately and then introducing coupling between these configurations to allow for reaction. The inelastic systems were developed in the form of self-coupled differential-integral equations and recoupled by the matrix element over internal states of the resonance energy between the adiabatic surfaces for the separate configurations. The model was applied to the D + H_2 → DH + H system and its isotopes in a two-level approximation. At the threshold energy (0.33 eV) for the D + H_2 → DH + H system, the calculated reactive total cross section is 1.62 Å^2 and the DH product is backscattered in the center-of-mass system. (auth)

20983 DIPOLE MOMENTS OF WATER AND HEAVY WATER USING GLYCEROL AS A POLAR SOLVENT, AND SOME OTHER RELATED PROPERTIES. Rizk, H. A.; Girgis, Y. M. (Univ. of Cairo). Z. Phys. Chem. (Leipzig); 243: 110-20(1970).

The applicability of a modified form of Onsager's equation to dilute solutions of water and heavy water in glycerol, and conversely to dilute solutions of glycerol in water and heavy water, affords dipole moment values for these liquids, at the condition of infinite dilution, which are in satisfactory agreement with those obtained by other authors in the usual way of using nonpolar solvents and applying Debye's equation. On the assumption that the infrared dispersion in water and heavy water is due to dipole rotation, the high dielectric constant of each of these two liquids is accounted for satisfactorily with the help of Kirkwood's equation by considering the value, 6, for the coordination number. Adopting, on the other hand, the suggestion that this dispersion is due to distortion polarization, estimates are made of the optical dielectric constants of both liquids from the Onsager and Kirkwood equations. Reasonable agreement was found between the values calculated in this way and those cited in the literature. (auth)

20984 ISOTOPIC EXCHANGE BETWEEN HYDROGEN AND WATER AT HIGH PRESSURES. Fodor, T.; Margineanu, P.; Olariu, A. (Inst. of Nuclear Physics, Cluj). Stud. Cercet. Fiz.; 22: 697-705(1970). (In Rumanian).

The effects of pressure on the isotopic exchange between H_2 and H_2O vapor catalyzed by $Ni-Cr_2O_3$ were studied. High pressure equipment used for the rate constant determinations is described. It was established that the isotopic exchange rate at low p_{H_2O} (vapor partial pressure) is independent of the p_{H_2} (hydrogen partial pressure). In this case the rate limiting step is the dissociative chemisorption of water. At high p_{H_2O} the process is hindered by water chemisorption, and the isotopic exchange rate depends on the ratio p_{H_2}/p_{H_2O}. (auth)

20985 N-BENZYLISOQUINOLINIUM 4-DITHIOCARBOXYLATE ADDUCTS FROM N-BENZYLISOQUINOLINIUM HALIDES AND CARBON DISULFIDE. Baldwin, John E.; Duncan, James A. (Univ. of Oregon, Eugene). J. Org. Chem.; 36: 627-31 (12 Mar 1971).

N-Benzylisoquinolinium halides, when combined with carbon disulfide in alkaline aqueous dioxane, give both the mesoionic cycloadducts first described by Kröhnke and Steuernagel and products identified as N-benzylisoquinolinium 4-dithiocarboxylates. The derivation of this structural assignment through physical methods and deuterium-labeling experiments and a plausible rationale for the formation of these novel adducts are presented. (auth)

20986 PRIMARY DEUTERIUM ISOTOPE EFFECT AND HYDRIDE TRANSFER REACTIONS. Scott, Kenneth Guy. Washington, D. C.; Georgetown Univ. (1970). 268p. University Microfilms Order No. 70-26,666.

Thesis.

Primary deuterium isotope effects were determined at 25°C for four hydride transfer reactions between tertiary carbonium ions and tertiary hydrocarbon donors. These reactions are: (i) the abstraction of hydride by the 1-adamantyl cation generated in solutions of 1-adamantanol in 80% sulfuric acid from 2,2,3-trimethylbutane (k_H/k_D = 15.3 ± 1.0) and methylcyclohexane (k_H/k_D = 17.4 ± 1.6), (ii) the transfer of hydride from methylcyclohexane to the 3-homoadamantyl cation generated in solutions of 1-adamantylcarbinol in 80% sulfuric acid (k_H/k_D = 23 ± 4), and (iii) the homogeneous hydride transfer reaction between the triphenylcarbonium ion generated from triphenylcarbinol in 10:1:1 (vol) trifluoroacetic acid: trifluoroacetic anhydride: carbon tetrachloride and tris-(p-tolyl)methane (k_H/k_D = 8.3 ± 0.3). These isotope effects are believed to be larger than any previously reported in the literature for other hydride transfer reactions and indicate that isotope effect magnitude may not be used to distinguish proton, hydrogen atom, and hydride transfer mechanisms. Additional studies showed that extensive bridgehead hydride (deuteride) exchange occurred in homoadamantane involving all four positions in the presence of 96% sulfuric acid and excess partially deuterated methylcyclohexane. In 80% sulfuric acid the extent of bridgehead exchange in homoadamantane was much less and occurred only at two positions. However, under these conditions, no exchange occurred in adamantane product formed by hydride (deuteride) transfer. This difference in deuterium incorporation as a function of solvent composition and bridgehead reactivity is viewed as the result of bridgehead oxidation of initially formed product by the solvent to a corresponding cation followed by further hydride (deuteride) transfer from the donor. The results point to a general scheme wherein adsorption of hydrocarbon onto the sulfuric acid interface precedes a rapid hydride (deuteride) transfer. The possible influence of heterogeneity on the net isotope effects is discussed in addition to nonclassical penetration of potential energy barriers (the tunnel effect). (Diss. Abstr. Int. B)

20987 MICROWAVE SPECTRA OF VINYLACETYLENE AND MONODEUTERO VINYLACETYLENE IN GROUND AND EXCITED VIBRATIONAL STATES. Hirose, Chiaki (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.: 43: 3695-8(Dec 1970).

The microwave spectra of vinylacetylene, CH_2CHCCH, and monodeutero-vinylacetylene, CH_2CHCCD, were observed in the ground state and several vibrational excited states. The vibration-rotation constants $\alpha_1^{(a)}$, $\alpha_1^{(b)}$, $\alpha_1^{(c)}$, $\alpha_2^{(a)}$, $\alpha_2^{(b)}$, and $\alpha_2^{(c)}$, were obtained as 1.370, −18.32, −7.73, −907, −2.78, and −8.97 MHz for CH_2CHCCH, and 2.010, −16.66, −7.05, −1,640, −2.18 and −7 84 MHz for CH_2CHCCD, respectively, the error limits being ±50 MHz for $\alpha^{(a)}$'s and ±0.03 MHz for $\alpha^{(b)}$'s and $\alpha^{(c)}$'s. Electric dipole moments obtained are 0.223 ± 0.020 and 0.206 ± 0.008 Debye for CH_2CHCCH and CH_2CHCCD, respectively, which are quite different from the values reported previously. (auth)

20988 TEMPERATURE DEPENDENCE OF THE THERMAL DIFFUSION FACTOR OF ORTHO- AND PARA-DEUTERIUM IN THE REGION 23°K TO 165°K. Schuette, R.; Koerting, K. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys. Chem. (Frankfurt); 71: 329-31(Oct 1970). (In German).

For comparison with the thermal diffusion of ortho- and para-hydrogen, the thermal diffusion factor for ortho- and para-deuterium in the region between 23 and 165°K was determined using two concentric thermal diffusion tubes. Results are presented in a diagram. (M.C.G.)

20989 BASE-CATALYSED H–D EXCHANGE IN 1-METHYLTHIOLANIUM IODIDE. Barbarella, G.; Garbesi, A.; Fava, A. (Univ., Geneva). Helv. Chim. Acta; 54: 341-3(1971).

The kinetics of the base-catalyzed H/D exchange of the 1-methylthiolanium cation in heavy water was studied. Of the four α-methylene protons, two exchange much more rapidly than the other two, a result that requires that reprotonation of the carbanion intermediate occurs with retention of configuration. NMR spectral analysis indicates that the protons undergoing faster exchange bear a trans relation to the lone-pair on sulfur. This conclusion appears to conform to Wolfe's theory on the stability of carbanions. (auth)

Physical Chemistry

Refer also to abstracts 21089, 21145, 22162, 22164, 22645, and 22652.

20990 (EUR-4597) EFFECT OF VARIOUS IMPURITIES ON THE ELECTRICAL CONDUCTIVITY OF ORGANIC COOLANT LIQUIDS. Van Velzen, D.; Langenkamp, H.; Serrini, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 28 Oct 1970. 24p. Dep. NTIS (U. S. Sales Only). EUR F.Fr. 4.45.

The effect of various impurities in the ppM range on the electric conductivity of organic coolant liquids was investigated. The experiments were carried out in a small versatile loop. The analytical equipment for operation in the MK-5 loop of the ESSOR reactor was tested. It appears that it is not possible to use the electric conductivity as a measure of the total chlorine content, since insufficiently dissociated compounds do not influence the

electric conductivity. Most probably, these compounds are not very active as fouling promotors. Continuous recording of the electric conductivity in high-purity organic coolants is a useful operation, since any increase of the conductivity is caused by an increase of the impurity content. (auth)

20991 (INIS-mf-10) VOLATILITY RATES OF U_3O_8 PHASE IN DIFFERENT ATMOSPHERES AT HIGH TEMPERATURES. Chandrasekharaiah, M. S.; Sreedharan, O. M.; Dharwadkar, S. R. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 1970. 7p. (CONF-700218-2). NTIS (U. S. Sales Only).

From Symposium on materials science research; Bangalore, India (24 Feb 1970).

The U_3O_8 phase evaporates as UO_3 in air or oxygen at temperatures above 1000°C. The rate of volatility and stoichiometric composition of the condensed phase were observed to be a function of the surrounding gaseous environment. A transpiration method was developed to study the variations in equilibrium vapor pressures and hence the variations in the rates of evaporation in pure oxygen and oxygen containing water vapor. Some preliminary observations indicated the increase in volatility in the presence of moisture at a given temperature. (auth) (INIS)

20992 (ORO-3955-2) CRYSTAL STRUCTURE AND MORPHOLOGY OF HYDROUS OXIDES AND HYDROXIDES IN THE LANTHANIDE AND ACTINIDE SERIES. Progress Report. Milligan, W. O. (Baylor Univ., Waco, Tex.). Feb 1971. Contract AT(40-1)-3955. 38p. Dep. NTIS.

Research progress is reported on: aging of lanthanide trihydroxides, lattice constants for the standard hexagonal form of lanthanide trihydroxides, preparation and characterization of a new phase of erbia, $Nd(OH)_3$ and its structure, and morphology of actinide hydroxides. (M.C.G.)

20993 LUMINESCENCE SPECTRA AND STRUCTURE OF URANYL PROPIONATES. Alikhanova, Z. M.; Zolin, V. F.; Fisher, P. S.; Ellert, G. V. Zh. Neorg. Khim.; 15: 3119-23(Nov 1970). (In Russian).

As a result of the analysis of electronic oscillations of the spectra of uranyl propionates and lanthanide uranyl propionates, data were obtained on the presence of bridge carboxylic groups in the first coordination sphere of lanthanide uranyl propionates. For bidentate carboxylic groups in propionates there are characteristic oscillations with frequencies in the region of 590 cm^{-1} and for bridge carboxylic groups in the region of 630 cm^{-1}. (tr-auth)

20994 PREPARATION AND CHARACTERISATION OF SOME Np(VII) COMPOUNDS. Awasthi, S. K.; Martinot, L.; Fuger, J.; Duyckaerts, G. (Lab. of Nuclear Chemistry, Liege). Inorg. Nucl. Chem. Lett.; 7: 145-51(Feb 1971).

The following Np(VII) compounds: Li_5NpO_6, $Ba_3(NpO_5)_2$, Ba_2NaNpO_6, and Ba_2LiNpO_6 were prepared by reactions between solids at high temperature. From powder diffraction data, the lattice parameters of Li_5NpO_6, Ba_2NaNpO_6, and Ba_2LiNpO_6 were calculated. These compounds appear to be isomorphous with the corresponding technetium and rhenium compounds. (auth) (UK)

20995 TEMPERATURE COEFFICIENTS AND CHANGES IN INTERIONIC DISTANCES IN CRYSTALLINE PLUTONIUM COMPOUNDS AT DIFFERENT TEMPERATURES. Krestov, G. A.; Krestova, N. V. Radiokhimiya; 12: 600-6(1970). (In Russian).

The temperature coefficient and changes in the interionic distances of certain crystalline compounds of plutonium and their ionic components at various temperatures were found with the aid of a method developed by the authors. PuF_3, $PuCl_3$, $PuBr_3$, PuI_3, PuF_4, α-Pu_2O_3, β-Pu_2O_3, Pu_2S_3, and PuO_2 were studied. An analysis of the changes in these quantities was made. It was found that the change in the interionic distances in the temperature interval $298.15 - T^*_mK$ reaches 0.05 Å, while the change in the radii of the ions of plutonium(III) and plutonium(IV) reaches 0.02 Å and 0.01 Å, respectively. (tr-auth)

20996 OXIDATION KINETICS OF CARRIER-FREE TETRAVALENT PROTACTINIUM IN AQUEOUS MEDIA. Manier, M.; Genet, M. (Univ., Paris). Rev. Chim. Miner.; 7: 1087-1100 (1970). (In French).

Oxidation rate of carrier-free $^{233}Pa^{4+}$ in aqueous acid solutions (HCl, $HClO_4$, HNO_3, and H_2SO_4) depends upon $[H^+]$ and upon the ionic forms of protactinium. In perchloric acid the variation of $[Pa^{4+}]$ versus time and $[H^+]$ is: $[Pa^{4+}]_t = [Pa^{4+}]_0 e^{-\beta t \alpha [H+]}$ and for H^+, Na^+, Cl^-, ClO_4^- media, α and β parameters depend upon $[Cl^-]$. The activation energy of oxidation reaction of $^{233}Pa^{4+}$ is: 9 kcal · $mole^{-1}$ for 0.34M $HClO_4$ and 11 kcal · $mole^{-1}$ for 1M and 6M HCl. (France)

20997 α FORM OF AMERICIUM SESQUISULFIDE AND AMERICIUM MONOSULFIDE. Damien, D. (CEN, Fontenay-aux-Roses, France). Inorg. Nucl. Chem. Lett.; 7: 291-7(Mar 1971).

The preparation and crystallographic characterization of an orthorhombic form of americium sesquisulfide (called α form) and its thermal transformation in monosulfide and γ sesquisulfide are described. (UK)

Radiation and Nuclear Chemistry

Refer also to abstract 21076.

20998 (RISO-M-1332) ABSTRACTS AND PAPERS SUBMITTED TO THE MEETING OF THE NORDIC SOCIETY FOR RADIATION RESEARCH AND RADIATION TECHNOLOGY AT THE TECHNICAL UNIVERSITY OF DENMARK AND THE DANISH ATOMIC ENERGY COMMISSION RESEARCH ESTABLISHMENT, RISOE, 8th AND 9th FEBRUARY 1971. Pagsberg, P. (ed.) (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan 1971. 57p. (CONF-710205-(Absts.); CONF-710206-(Absts.)).

The abstracts concern a wide variety of subjects within fundamental radiation chemistry and physics, and radiation technology, e.g., γ radiolysis and pulse radiolysis, hot atom chemistry, positron annihilation, ion implantation, radiation biochemistry and biology, sterilization, dosimetry, experimental instrumentation and data processing, industrial technique and instrumentation. One paper "Radiation Induced Species in DNA and its Bases" is included. (Denmark)

20999 EINFUEHRUNG IN DIE STRAHLENCHEMIE MIT PRAKTISCHEN ANLEITUNGEN. (Introduction to Radiation Chemistry with Practical Instructions). Henglein, Arnim; Schnabel, Wolfram; Wendenburg, Juergen. Weinheim, Ger.; Verlag Chemie GmbH (1969). 408p.

Reaction kinetics in radiation chemistry and use of radiation for chemical synthesis are considered. Topics covered include: yields, absorbed dose, chemical γ dosimetry, ionizing effects in gases and liquids, elementary processes in the absorption of γ and x rays, specific energy losses of charged particles, chemical reactions caused by neutrons, formation and reactions of excited molecules and positive and negative ions, radiation chemistry of water, reaction kinetics, chemical aspects of radiation biology, radiation chemistry of hydrocarbons, electrons and ions in solids, preparative radiation chemistry, and radiation chemistry of polymer systems. (M.C.G.)

Radiation Effects

21000 (CONF-700816-(Vol.2), pp 526-38) EFFECT OF GAMMA RADIATION ON ADSORPTION OF IODINE AND METHYL IODIDE ON ACTIVATED CARBON. Jones, L. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The effect of gamma radiation on the adsorption of iodine and methyl iodide on activated carbon exposed to flowing mixtures of steam and air is being measured. The steam–air–iodine mixtures are exposed to a radiation field of $\sim 1.7 \times 10^7$ rads/hr while flowing through a bed of test carbon. Test conditions simulate a postulated loss-of-coolant accident where adsorption of radioiodine on carbon beds would produce an intense gamma radiation field. The test facilities and results of tests that are under way to define the effects on carbon adsorption efficiency of variables such as face velocity, relative humidity, temperature, type of carbon, carbon service age, iodine and methyl iodide concentration in the steam–air mixture and loading on the carbon are described. (auth)

21001 CONNECTION OF THERMOSTIMULATED CURRENT IN IRRADIATED POLYMERS WITH MOLECULAR MOTIONS. Sichkar, V. P.; Vaisberg, S. E.; Karpov, V. L. (Inst. of Physical Chemistry, Moscow). Vysokomol. Soedin., Ser. B; 12: 510-12(Jul 1970). (In Russian).

Experimental data were obtained for the thermostimulated current in γ-irradiated low-density polyethylene, polypropylene, polystyrene, poly(trifluoroethylene), poly(tetrafluoroethylene), and poly(vinyl chloride) films. (tr-auth)

21002 STRENGTH OF POLYMERS IN THE PROCESS OF IRRADIATION. Mikitishin, S. I.; Mikityuk, A. O.; Tynnyi, A. N. (Physical-Mechanical Inst., Lvov). Fiz.-Khim. Mekh. Mater.; 6: No. 4, 116-19(1970). (In Russian).

A method is proposed for determining the durability of polymer material during the simultaneous action of mechanical stress and different forms of ionizing radiations. The calculated values con-

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form well with experimental data for poly(methyl methacrylate). (tr-auth)

21003 COMMENTS ON THE PAPER AQUOLUMINESCENCE: AN ALTERNATIVE MODE OF RELEASE OF ENERGY STORED IN γ-IRRADIATED CRYSTALS. Mittal, Jai P.; Shankar, J. (Bhabha Atomic Research Center, Trombay, India). Radiochem. Radioanal. Lett.; 6: 115-17(2 Mar 1971).

Comments are presented on the paper covered by NSA 25: 2227. (M.C.G.)

21004 REPLY OF THE AUTHOR TO THE COMMENTS ON THE PAPER AQUOLUMINESCENCE: AN ALTERNATIVE MODE OF RELEASE OF ENERGY STORED IN γ-IRRADIATED CRYSTALS. Arnikar, H. J. (Univ. of Poona, India). Radiochem. Radioanal. Lett.; 6: 119(2 Mar 1971).

21005 INFLUENCE OF TRACK STRUCTURE ON INITIAL RECOMBINATION IN GASES. Booz, J. (Univ., Goettingen, Ger.). pp 19-27 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

A survey is given on the theory of the recombination coefficient for the recombination of ions in gases. Cluster recombination, columnar recombination, volume recombination, and the boundary regions are discussed. The formulae are applied to measurements of ion recombination after well-defined recombination times in order to evaluate the time dependence of the variance of linear ion density. For recombination times t greater than 1 msec, this variance decreases as $t^{-\frac{1}{2}}$. (auth) (UK)

21006 PREFERENTIAL RECOMBINATION OF IONS IN GASES AT HIGH PRESSURES. Koepp, R. (Univ., Goettingen, Ger.). pp 28-34 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Preferential recombination was studied in gases (N_2, O_2, air) at high pressures (p_{max} = 200 atm), irradiated by 50-kV x rays. After definition of the terms preferential recombination of the first and second kind, a method is described to differentiate between initial (columnar) and preferential recombination. The result is represented as a plot of escape probability versus relative density. The track parameters were determined by Jaffé's theory. They can only give an order of magnitude. Nevertheless they are in agreement with parameters used to fit the curve of escape probability by Onsager's theory. (auth) (UK)

21007 RADIATION DEFECTS IN ORGANIC SINGLE CRYSTALS. Kotsch, E. (Univ., Giessen, Ger.). Z. Naturforsch.; 25a: 1982-3(Dec 1970). (In German).

Radiation defects in pure single crystals of anthracene, fluorene, and carbazole were investigated using EPR spectra. 45-MeV electrons on a tungsten target were used to generate bremsstrahlung for the irradiation. The EPR line intensities were measured. For fluorene and carbazole, two different radicals were found with the EPR field being parallel to the c-axis of fluorene and to the a-axis of carbazole. The hyperfine structure of the spectra is discussed. (D.L.C.)

21008 DELAY IN BOILING OF LIQUID SHEET GLASS ON ELECTRON IRRADIATION. Dudek, H. J. (Univ., Karlsruhe, Ger.). Naturwissenschaften; 57: 450(Sep 1970). (In German).

When a well-collimated electron beam of 100 keV hits the surface of material, either formation of holes or melting occurs. In the case of hole formation, material is removed in an eruptive manner that results from delay in boiling. In sheet glass, holes can be drilled with this method. If, however, the glass moves during irradiation, the material boils and forms glass foam. Various transition states between hole formation and boiling can be obtained by use of a pulsed electron beam with selection of appropriate pulse frequency, impulse duration, beam diameter, and speed of glass motion. (H.B.G.)

21009 EFFECT OF RADIATION CROSSLINKING OF POLYETHYLENE ON THE FORMATION OF AUTOHESION WELDING JOINTS. Vakula, L. V.; Mishustin, V. I.; Gorchakova, V. M.; Voyutskii, S. S. (Inst. of Fine Chemical Tech., Moscow). Vysokomol. Soedin., Ser. A; 13: 92-8(Jan 1971). (In Russian).

Irradiation of low-density polyethylene (LDP) with γ rays (1 to 50 MRad) decreased its ability to form autoadhesive joints during welding because of structural interference with diffusion of the macromolecules. Use of the nonirradiated films increased the strength of the joint because of improved microrheological processes in the contact zone. The lower strength of the welded joints of the irradiated LDP films can be attributed to changes in the polymer properties during welding (mainly a decrease of crystallinity). (R.V.J.)

21010 IRRADIATION EFFECTS IN VITREOUS AND CRYSTALLINE Li_2O–$2SiO_2$. Bettinali, C.; Petrucci, M. (Univ., Rome). Z. Phys. Chem. (Frankfurt); 72: 23-33(Nov 1970).

A detailed analysis of thermoluminescence (TL) in vitreous and devitrified, gamma-irradiated $Li_2O + 2SiO_2$ was done. Electron spin resonance and optical absorption were also investigated. Experimental activation energy values were compared with values calculated according to different models. Trapped excitons or polarons are proposed as the origin of TL. A dependence of activation energy on concentration of centers was found. (auth)

Radiation Processes

Refer also to abstract 21586.

21011 (IAEA-R-565-F) STUDY OF IRRADIATED BAMBOO-PLASTIC COMBINATIONS. Hao, P. H. C. (International Atomic Energy Agency, Vienna (Austria)). May 1970. 15p. NTIS (U. S. Sales Only).

Bamboo–plastic combinations (BPC) can be prepared by the impregnation of bamboo with a mixture of 75% vinyl chloride and 25% vinyl acetate followed by irradiation with gamma rays. During the radiation-induced polymerization it was found that dose rate has a significant effect on the degree of conversion and the temperature rise on BPC. The electric and fire resistance tests were conducted to evaluate the performance of BPC. (INIS)

21012 RADIATION TECHNOLOGY FOR STUDYING FIBERGLASS. P'yankov, G. N.; Morozov, A. V.; Omel'chenko, S. I.; (and others). Khim. Prom. Ukr.; No. 4, 8-10(Jul 1970). (In Russian).

Preparation of fiber glass using electron accelerators as the radiation source is described. Design of the installation and operations are explained using a cylindrical shell with a transverse winding. An accelerator with a maximum electron energy of 0.4 MeV was used as a source of fast charged particles. (R.V.J.)

21013 RADIATION HARDENING OF COMMERCIAL POLYESTER RESINS. Proksch, E. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Kunstoffe; 60: 414-19(1970). (In German).

The radiation hardening of some commercial polyester resins of various composition was investigated particularly under gamma irradiation. At low dose rates and under exclusion of air oxygen (using technical nitrogen as cover gas) the necessary doses for hardening are 1 MRad and below, for irradiation in air, 3 to 10 MRad. The application of low monomer concentrations and a partial substitution of styrene by glycol dimethacrylate seem to be advantageous. The results concerning the resin composition are in good agreement with results of irradiations at high dose rates (using electron accelerators) cited in the literature. (INIS)

21014 ACTIVATION OF AN ALUMINOSILICATE CATALYST BY IONIZING RADIATION. Ranchenkov, G. M.; Kazanskaya, A. S.; Kozlov, L. L.; (and others). Tr., Mosk. Inst. Neftekhim. Gazov. Prom.; No. 86, 126-34(1969). (In Russian).

Studies were made of the kinetics of polymerization of amylene in the presence of γ-irradiated and nonirradiated synthetic aluminosilicate catalysts of various composition, and in the presence of industrial aluminosilicates containing various amounts of nickel oxide. The activity of the synthetic aluminosilicates studied increased with increasing aluminum oxide up to 50 wt %. The activity of aluminosilicate catalysts also increased following a preliminary γ irradiation. Polymerization kinetics in the presence of irradiated and nonirradiated aluminosilicate catalysts containing nickel oxides remained unchanged. It was also found that preliminary γ irradiation of aluminosilicates increased their electric resistance. (R.V.J.)

21015 EXPERIMENTAL VERIFICATION OF RADIATION METHOD FOR PRODUCTION OF TETRACHLOROALKANES. Beer, A. A.; Zagorets, P. A.; Inozemtsev, V. F.; (and others). At. Energ. (USSR); 29: 461-3(Dec 1970). (In Russian).

An experimental installation producing new products (tetrachloroalkanes) by radiation processing was put into operation in 1967. Ordinarily tetrachloroalkanes were produced by telomerization reactions of ethylene and carbon tetrachloride: $x \cdot C_2H_4 + CCl_4 \rightarrow Cl(CH_2CH_2)_xCCl_3$. Such reactions are usually initiated by free radicals during thermal degradation of peroxides or nitrogen

compounds. However, published data revealed that such a reaction can be initiated by γ radiation. An experimental installation was constructed for γ-telomerization between CCl_4 and C_2H_4 and rectification of tetrachloroalkane. On the basis of optimum reactor dimensions and source activity, the cost of tetrachloroalkane was 10 to 20 times cheaper than the product from the conventional process. (R.V.J.)

21016 RADIATION POLYMERIZATION OF SOLID FORMALDEHYDE AT 80 TO 90°K. Kiryukhin, D. P.; Kaplan, A. M.; Barkalov, I. M.; Gol'danskii, V. I. Vysokomol. Soedin., Ser. B; 12: 491-2(Jul 1970). (In Russian).

A calorimetric study was made of the gamma-radioinduced polymerization of solid formaldehyde at 80 to 90°K. Quantitative measurement showed the yield of solid polyformaldehyde to be G ≥ 100,000. (tr-auth)

21017 RADIATION POLYMERIZATION OF PERFLUOROCYCLOBUTANE IN THE CRYSTALLINE STATE. Chuiko, K. K.; Bruk, M. A.; Abkin, A. D. Vysokomol. Soedin., Ser. B; 12: 492-3(Jul 1970). (In Russian).

It was established that by γ irradiation crystalline perfluorocyclobutane was polymerized by opening of the ring and the formation of stable linear polymers. If the irradiation is conducted at −196°C, the ir spectra of the solid polymer formed coincides with the ir spectrum of polytetrafluoroethylene. The yield of the polymer depends linearly on the radiation dose. (tr-auth)

21018 RADIATION PROCESSING OF THIN ORGANIC FILMS AND SURFACE COATINGS USING LOW-ENERGY ELECTRON ACCELERATORS. McLaren, K. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Proc. Roy. Aust. Chem. Inst.; 37: 340-3(Dec 1970).

An outline is given of electron irradiation applications in the polymer, textile and surface coating industries with emphasis on electrons in the keV range. Processes discussed are radiation crosslinking of polymers, radiation curing of paints and thin surface coatings, and graft polymerization on textiles including wool. A comparative cost analysis between radiation and thermal curing costs is tabulated. (Australia)

21019 RADIATION-INDUCED GRAFT POLYMERIZATION TO CELLULOSE. Moore, P. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Rev. Pure Appl. Chem.; 20: 139-58(Dec 1970).

A review is given of developments in monomer polymerization to wood–plastic composites and to pure forms of cellulose by both the preirradiation and simultaneous irradiation methods. Factors influencing preirradiation (substrate, environment, grafting site stability, grafting solutions, time, temperature, and presence of metal ions) are discussed, and suitable monomer compositions for grafting to cotton, viscose, Polynoshico rayon, and cellulose pulp are tabulated. These parameters are also considered for simultaneous irradiation, as well as water effects on grafting, dose, and dose rate and monomer to solvent ratio. Optimum compositions of monomer solutions for grafting to various cellulose types, including cotton, rayon, cellophane, filter paper, and newsprint are tabulated. Optimum comonomer ratios for rayon are also listed. The graft polymerization reaction mechanism is analyzed and typical G-values listed. Sections are devoted to the gel effect, the action of ionizing radiation on cellulose, the nature of graft polymers and the properties of grafted fibres. A table of properties for rayon and cotton is given. (127 references) (Australia)

21020 STRUCTURE AND PROPERTIES OF ABS POLYMERS. IV. PARTICLE SIZE DETERMINATION OF BUTADIENE HOMO- AND GRAFT-POLYMER LATTICES WITH THE ELECTRON MICROSCOPE. Kaempf, Guenther; Schuster, Herbert (Farbenfabriken Bayer AG, Leverkusen, Ger.). Angew. Makromol. Chem.; 14: 111-29(Nov 1970). (In German).

A summary of the different preparation methods for electron microscope studies on lattices (hardening and contrasting by addition of OsO_4, Br_2, uranyl acetate, etc.; addition of monomeric styrene, followed by γ or x irradiation; electron curing, taking of surface replicas after low-temperature shock, etc.) is followed by a discussion of the customary methods for interpretation of electron micrographs of lattices. Particular attention is drawn to the possibilities for errors in measurement of the particle size distribution of polybutadiene lattices after fixation with OsO_4. A series of measurements corresponding to increasing fixation times and/or rising concentrations of the fixation solution shows that low fixation results in flattening, while high fixation (owing to incorporation of OsO_4) results in swelling of the spherical particles. In both cases excessive particle diameters are obtained. Determinations of mass with an integration photometer are used as controls. In connection with measurements to find the particle sizes of butadiene homopolymer and graft polymer lattices the ratio between the volume of the grafting stock and that of the graft polymer is determined and satisfactory agreement with the starting ratio is found. (auth)

21021 PREPOLYMERS OBTAINED BY IRRADIATION. Feuillet, Jean; Frignet, Georges (to Saint-Gobain Techniques Nouvelles). French Patent 1,586,610. 19 Jan 1970. Filed 19 Jun 1967. (In French).

The equipment and the procedure to be used in the industrial manufacture of a prepolymer of polymerizable materials is described. Products produced in this way are in a state intermediate between that of a monomer and that of a polymer. The equipment and procedure for acquiring the monomer of the polymerizable materials in the gaseous, liquid, liquefied gas, or solidified liquid states are described; these states exhibit new properties. Three different methods of manufacturing prepolymers, all making use of radioinduced reactions, are described. (France)

21022 INDUSTRIAL RADIATION CURED COATINGS SPEED PRODUCT FINISHING. Mock, John A. Mater. Eng.; 10: No. 47, 56-7; 59(Oct 1970).

The chief merits of electron-cured coatings as opposed to any conventional polymerization method for commercial use are described. The type of coatings used, potential radiation-cured-coated commercial products, and a comparison of operational costs for radiation vs oven curing of coatings are listed. (D.P.O.)

21023 VAPOR PHASE RADIATION-THERMAL OXIDATION OF BENZENE WITH MOLECULAR OXYGEN UNDER FAST ELECTRON IRRADIATION. Timofeev, V. D.; Yur'ev, Z. N.; Klapishevskaya, Z. B.; Borisov, E. A. (Inst. of Physical Chemistry, Moscow). Neftekhimiya; 10: 42-7(Jan-Feb). (In Russian).

The radiation-thermal oxidation of benzene with molecular oxygen was studied in terms of the effect of temperature on the yield of phenol. The yield increased with temperature increase. A trend towards higher yields with more oxygen was observed. There was an inverse relationship of the yield to contact time. The yield of phenol in this reaction was found to be always higher than in the thermal reaction, maximum yield being 4 wt %. The radiation-chemical yield of phenol at maximal concentration was 40 molecules per 100 eV of the absorbed radiation energy. The effective energy of activation for the formation of phenol was found to be 70 kcal/mole for the thermal process and 49 kcal/mole for the radiation-thermal process at 700 to 780°C. (JPRS)

21024 METHOD FOR THE STABILIZING OF POLYOXYMETHYLENE USING HIGH ENERGY RADIATION AND ACETIC ANHYDRIDE. Yamashina, Hisao; Ito, Akihiko; Iwai, Tadashi; Yayashi, Koichiro; Okamura, Seizo (to Japan Atomic Energy Research Inst.). U. S. Patent 3,553,090. 5 Jan 1971. Priority date 21 May 1966, Japan.

Esterification of highly crystalline polyoxymethylene was induced by ionizing radiation in the presence of acetic anhydride. The polyoxymethylene of highly crystalline structure, which is not easily esterified, is now thoroughly esterified in a heterogenous system at rather low temperature by applying ionizing radiation and thus its thermal stability is remarkably improved. (Offic. Gaz.)

21025 RADIATION POLYMERIZATION OF COMPACTED TRIOXANE. Marans, Nelson Samuel; Mitchell, Fern Wood (to W. R. Grace and Co.). U. S. Patent 3,547,793. 15 Dec 1970. Filed 5 Jun 1968.

A process for preparing a high-molecular-weight polyoxymethylene polymer comprises: (a) compacting trioxane in the solid state; (b) irradiating the compacted trioxane; (c) polymerizing the irradiated trioxane; (d) separating the resulting polyoxymethylene polymer from nonpolymerized trioxane; and (e) recovering the separated polymer. (Offic. Gaz.)

21026 ANHYDROUS, IRRADIATION TETRAFLUOROETHYLENE–ETHYLENE COPOLYMERIZATION. D'Agostino, Vincent F.; Lee, Joseph Y. C. (to RAI Research Corp.). U. S. Patent 3,556,965. 19 Jan 1971. Filed 4 Oct 1968.

The gas-phase, radiation-induced, copolymerization of tetrafluoroethylene with ethylene at room temperature under anhydrous conditions is reported. The resulting copolymer has excellent physical and chemical characteristics, and is particularly suitable as a dielectric material. (Offic. Gaz.)

21027 RADIATION TREATMENT OF MATERIALS. Mytelka, Alan I.; Manganelli, Raymond M. U. S. Patent 3,553,089. 5 Jan 1971. Filed 22 Sep 1967.

Aqueous waste effluents containing dissolved or suspended organic materials are rendered more suitable for subsequent treatment and/or disposal by adjusting the pH to a value in the range 9 to 12 and subjecting the waste effluent to penetrative ionizing radiation in the presence of oxygen and in the presence of a multivalent metal cation, such as a ferrous ion. Desirably, a chloride ion is incorporated in the waste effluent during treatment. This treatment is particularly applicable to the treatment of the highly colored waste effluents produced in the manufacture of dyestuffs, especially azo dyestuffs. (Offic. Gaz.)

21028 INFLUENCE OF IONIZING RADIATION ON THE ACTIVITY AND SELECTIVITY FOR CATALYTIC HYDRIDATION OF CARBON MONOXIDE. Koelbel, Herbert; Henne, Hans Joerg; Hammer, Hans (Technische Univ., Berlin). Z. Phys. Chem. (Frankfurt); 72: 44-9(Nov 1970). (In German).

Under the action of ^{210}Po α particles, ^{210}Bi β particles, ^{60}Co γ radiation, and 1.5-MeV electron beams, the activity of carrier-free Fe precipitation catalysts for Fischer–Tropoch synthesis decreased. The selectivity was turned in the direction of lower C numbers in the reaction products by the α and β particles. (tr-auth)

21029 PRODUCTION OF MULTILAYER, GRAFT-POLYMERIZED MATERIALS (PEMOSORS) BY RADIATION-POLYMERIZATION FROM THE GAS PHASE. Vlasov, A. V.; Komarova, L. I.; Korshak, V. V.; (and others) (Inst. for Organic Elementary Compounds, Moscow. All-Union Scientific Research Inst. of Synthetic Fibers, Moscow). Dokl. Akad. Nauk SSSR; 193: 615-17 (21 Jul 1970). (In Russian).

Twice-grafted materials were synthetized by successive polymerization from the gas phase. The monomers used were placed on stretched polyethylene and polypropylene films and fibers. The graft polymerization was carried out by exposing the original films and fibers and the once-grafted materials to x radiation in the presence of unsaturated monomer vapors. Pairs of monomers were selected for polymerization experiments from the following materials; acrylonitrile, vinylidene chloride, acrylic acid, vinyl chloride, styrene, and methyl methacrylate. The double graft-polymerization process yielded a 3-layer fiber and film, with a sharp boundary between layers. The orientation of the layers was examined by infrared spectroscopy with polarized light and by roentgenography. It is of interest to note that the orientation of the substratum was transmitted to the forming third grafted layer through an unoriented intermediate layer; the effect might be due to the reproduction of the directional grooves in the microrelief of the intermediate layer or to the cumulated remote effects of charged point defects. (TTT)

Radiolysis

Refer also to abstracts 21591, 21990, 22578, and 22585.

21030 (CEA-R-4146) PHYSICAL CHEMISTRY AND THE γ RADIOLYSIS OF HEXOGEN. Cherville, Jean (Commissariat a l'Energie Atomique (France). Centre d'Etudes Scientifiques et Techniques d'Aquitaine). Jan 1971. 58p. (In French). Dep. NTIS (U. S. Sales Only).

The physical chemistry of Hexogen, in particular the conformation of the molecule in the dissolved state, was studied. Comparison made between conformation in the solid and dissolved states indicated the existence of a lattice energy, probably associated with the explosive properties of the crystal. Gamma radiolysis in the solid state was studied. The most interesting effect was the delayed decomposition resulting from the diffusion of NO_2 created and trapped during the irradiation. It was found that Hexogen may be considered to be a radiolysis resistant explosive. (auth) (France)

21031 (NP-18719) RADICAL SCAVENGING IN γ-IRRADIATED POLY-4-METHYLPENT-1-ENE. Technical Note 156. Pinkerton, D. M.; Whelan, D. J. (Defence Standards Labs., Maribyrnong (Australia)). Nov 1970. 8p. Dep. NTIS (U. S. Sales Only).

The γ irradiation of poly(4-methylpent-1-ene) in the presence of oxygen at room temperature leads to the production of acetone ($G_{acetone} = 1.2$). It is suggested that acetone arises through decomposition of a peroxy radical resulting from the reaction of the oxygen with a side-chain alkyl radical. ESR measurements confirm that a peroxy radical is formed at 77°K. The role of free radicals in radioinduced crosslinking of poly(4-methylpent-1-ene) is discussed. (auth)

21032 (RFP-1561) RADIOLYSIS OF OIL-SOLVENT MIXTURES. Kazanjian, Armen R.; Horrell, David R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 18 Mar 1971. Contract AT(29-1)-1106. 6p. Dep. NTIS.

The radiolysis of trichloroethylene–dodecane and carbon tetrachloride–dodecane mixtures was investigated. The dodecane is a substitute for saturated hydrocarbon lubricants. Irradiations were made with gamma rays, and the total water extractable acids formed were determined over the entire range of concentrations. The acid yields were regarded as a measure of the corrosivity (toward plutonium) of the irradiated mixtures. The variation in these acid yields is explained on the basis of the radiation chemistry of the compounds. Some of the gaseous radiolysis products from 50% mixtures were identified by mass spectrometry. (auth)

21033 RADIOLYSIS OF 2,2'-AZO-BIS-ISOBUTYRONITRILE IN BENZENE SOLUTION. I. ENERGY TRANSFER IN BENZENE. Hirano, Katsuhiko; Masuda, Takahiro; Kondo, Masaharu (Tokyo Metropolitan Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 623-30 (Dec 1970).

Nitrogen is formed by the γ-radiolysis of 2,2'-azo-bis-isobutyronitrile (AIBN) in benzene solution. The 100 eV yield of nitrogen $G(N_2)$ was observed to be 1.4 at its asymptotic value attained above 0.02M AIBN. This and other results are interpreted in terms of energy transfer from excited benzene to AIBN. Experiments using cyclohexene as a selective quencher of the triplet benzene were performed. Above a G value of 1.4 for nitrogen formation, 0.8 can be attributed to the process via excited benzene in singlet state, and the remainder of the G value to the process via triplet state. Further experiments on γ ray radioinduced isomerization of stilbene in benzene containing AIBN have revealed that AIBN competes with trans-stilbene for the triplet benzene. The data obtained were analyzed on the basis of competition kinetics, which has resulted in a value of 2.7 for the yield of the triplet benzene. (auth)

21034 FORMATION OF FREE RADICALS IN POLYMERS BY SIMULTANEOUS ACTION OF IONIZING RADIATION AND LIGHT. Milinchuk, V. K.; Zhdanov, G. S.; Pshezhetskii, S. Ya. Vysokomol. Soedin., Ser. B; 12: 658-61(Sep 1970). (In Russian).

Electron paramagnetic resonance was used to study the formation of free radicals in polymers produced by the simultaneous action of ionizing radiation and light. It was established that an increase of concentration of free radicals occurred in polyacrylamide, polycaprolactam, and other polymers from the simultaneous action of γ radiation and light in comparison with their successive action. (tr-auth)

21035 INVESTIGATION OF FORMS OF STABILIZATION OF ^{35}S AND ^{32}P IN CARBON TETRACHLORIDE IRRADIATED IN A REACTOR. Petryaev, E. P.; Solov'eva, G. D.; Mironov, V. P. Radiokhimiya; 12: 626-30(1970). (In Russian).

The influence of radiolysis of the parent substance on the form of stabilization of radioactive isotopes was demonstrated. An aqueous extract from carbon tetrachloride irradiated in a nuclear reactor contains not only phosphite (2.4%) and trichloromethylphosphinic acid (7.3%), but also red phosphorus in an amount of 68.7%. Sulfuric acid (100%) was detected in the hydrolyzed products of the stabilization of radioactive sulfur. It is suggested that it is a product of the oxidative hydrolysis of chloride compounds of sulfur. (tr-auth)

21036 MEASUREMENT BY ELECTRON SPIN RESONANCE SPECTROSCOPY OF LOCAL CONCENTRATIONS OF RADIATION-PRODUCED RADICALS. Wyard, S. J. (Guy's Hospital Medical School, London). pp 86-92 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Electron spin resonance measurements of local concentrations of radicals, following low LET radiation, are reviewed; and are discussed in terms of current theories of radiation chemistry. (auth) (UK)

21037 SPATIAL DISTRIBUTION OF FREE RADICALS IN AQUEOUS SALT SOLUTIONS GAMMA-IRRADIATED AT 77K. Ershov, B. G.; Chernova, G. P. (Inst. of Physical Chemistry, Moscow). pp 93-5 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Information on the local concentrations of radicals within "spurs" can be obtained from an analysis of line-broadening EPR spectra as a function of the dose given. The line width of the H-atom spectrum reflects the local concentration of radicals in a spur and is found to remain constant until a dose is reached at which it is supposed that neighboring spurs begin to overlap. The relevant theoretical relations are discussed and experimental data are presented for γ-irradiated frozen salt solutions. (auth)

21038 ESR SPIN ECHO METHOD FOR DETERMINING THE SPATIAL DISTRIBUTION OF FREE RADICALS. Tsvetkov, Yu. D. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). pp 96-7 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The advantages of the electron spin echo (ESE) method of studying the spatial distribution of radicals are discussed, and preliminary results on γ-irradiated organic glasses at 77°K are reported. The ESE method of studying radiation-produced radicals is at present limited by the sensitivity of the available spectrometers, but once this limitation has been overcome the method should be a powerful tool for studying track effects. (auth) (UK)

21039 INFORMATION FROM INDUCED ELECTRICAL CONDUCTANCE AND FROM THE NONHOMOGENEOUS KINETICS OF CHARGE-SCAVENGING REACTIONS. Freeman, G. R. (Univ. of Alberta, Edmonton). pp 105-8 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The pairs of positive and negative charges generated during the radiolysis of a liquid either undergo geminate neutralization or they escape from each other by random diffusion. The competition between geminate neutralization and diffusive escape is strongly dependent on the initial distance between the energetically thermalized pair of charges. The ions that escape geminate neutralization can be measured by electrical conductance methods. Thus the magnitude of the radiation-induced conductance provides a measure of the competition between geminate neutralization and diffusive escape, and hence gives an indication of the magnitude of the separation distance between the charged species in spurs. More detailed information about the spacial distribution of charged species in spurs is obtainable by measuring the scavenger concentration dependence of charge scavenging reactions. (auth) (UK)

21040 INFLUENCE OF TRACK STRUCTURE IN RADIATION CHEMISTRY. Burns, W. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 143-59 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Recent developments in models for aqueous radiation chemistry, which depend on the distribution in energy of primary ionizing events, and therefore on the electron degradation spectrum, are considered first. The following phenomena, which appear to depend quantitatively on initial track structure, are then reviewed: the conductivity of irradiated organic liquids and the yield of free ions; the effects of ionic scavengers on radiation chemical yields; some results of kinetic spectroscopy, following pulse radiolysis; some optical, ESR and thermoluminescent properties of irradiated cooled glasses; the observation of high LET of differing product G-values for radiation of the same LET for particles of differing mass and for the same particle on either side of the Bragg maximum. The review contains a comparison of current models of ionization in irradiated liquids, and concludes with suggestions for further work. (57 references) (auth) (UK)

21041 NATURE AND REACTIONS OF INITIAL SPECIES IN RADIOLYSIS. Thomas, J. K. (Argonne National Lab., Ill.). pp 174-84 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The fundamental processes occurring in the radiolysis of liquids are discussed in terms of the reactions of ions and excited states. Experimental evidence to collaborate these reactions is provided from nanosecond pulse radiolysis studies of water, ethanol, aniline, cyclohexane, and benzene. The bearing that the experimental evidence has on the "spurs" or short tracks is also discussed. (auth) (UK)

21042 MOLECULAR OXYGEN AS A PRIMARY RADIATION CHEMICAL SPECIES IN THE HIGH LET RADIOLYSIS OF AQUEOUS SOLUTIONS. Hueber, R. P. O. (Univ. of Birmingham, Eng.). pp 185-9 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The origin of molecular oxygen released in high LET radiolysis from water and aqueous solutions has been investigated with ^3He particles and fast neutrons. The results showed that the molecular oxygen is released as a result of reactions in the early stages of the track formation and has, therefore, to be considered a primary radiation chemical species. (auth) (UK)

21043 SPUR REACTIONS AS STUDIED BY STEADY-STATE RADIOLYSIS. Cercek, B.; Kongshaug, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 210-18 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Hydrated electrons react with p-bromophenol to produce bromide ions. The yields of bromide ions and molecular hydrogen as a function of p-bromophenol concentration in deaerated aqueous solutions gave information about spur reactions. These results suggest that four distinct types of spurs exist at times longer than about 10^{-9} sec. Contrary to the predictions of the diffusion model there are no spur reactions between 0.5 and 1 nsec. The observed spur reactions do not contribute to the yields of the radiolytic transients in the bulk of the solution; the final fate of all the transients in the nanosecond-type spurs is to react with each other. It follows from the results that the radiolytic transients leading to the bulk-yields would be homogeneously distributed at times shorter than 0.5 nsec. (auth) (UK)

21044 MAGNETIC RESONANCE STUDIES OF METAL OLEFIN COMPLEXES. II. ELECTRON SPIN RESONANCE SPECTRA OF γ-IRRADIATED SILVER COMPLEXES WITH CYCLOHEXADIENES AND 1-METHYL CYCLOPENTENE. Gee, D. R.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). Can. J. Chem.; 49: 160-3(1 Jan 1971).

Electron spin resonance studies of silver cycloalkenyl radicals generated by γ-irradiation of polycrystalline silver cycloalkene complexes were extended to include the effect of alkyl substitution at the double bond, the effect of conjugation in cyclic diolefins and the effect of anions, on the formation of these silver cycloalkenyl radicals. (auth) (Canada)

21045 RELAXATION CURRENTS IN THE PULSE RADIOLYSIS OF KETONES. Vannikov, A. V.; Mal'tsev, E. I.; Bakh, N. A. (Inst. of Electrochemistry, Moscow). Dokl. Akad. Nauk SSSR; 195: 1131-4(11 Dec 1970). (In Russian).

Radiochemical processes in irradiated organic solutions were studied by a combined method of high-speed absorption spectroscopy and by measurements of relaxation currents during pulsed electron irradiation using methyl ketones irradiated at 4 MeV for 2.5 μsec. Relaxation current curves for deaerated and oxygen-containing media of methyl ethyl ketone (MEK) were constructed. The spectra of a short-lived optical absorption in deaerated MEK are analyzed. The results of pulsed radiolysis with optical recording revealed short-life absorption with a maximum of 900 mμ corresponding to the initial relaxation spectra. In the oxygen media the absorption disappeared. Additions of an electron acceptor to the anthracene system resulted in the disappearance of the absorption at λ_{max} = 900 mμ and the appearance of new absorption in the anthracene-inherent short wave region of λ_{max} = 730 mμ. In the short wave region absorption did not take place in the presence of combined anthracene and oxygen; neither did it take place in the long wave region in symmetric ketones (acetone and dipropyl ketone). (R.V.J.)

21046 ELECTRON PARAMAGNETIC RESONANCE STUDY OF SOME ALKYL SUBSTITUTED CYCLOALKENYL RADICALS. Gee, D. R.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). Can. J. Chem.; 49: 20-7(1 Jan 1971).

Well-resolved electron spin resonance (ESR) spectra are reported and analyzed for the radicals produced when samples of solid adamantane doped with alkyl substituted cycloalkenes are γ-irradiated at room temperature. (auth) (Canada)

21047 NMR STUDY OF THE GAMMA IRRADIATED ETHANOL–WATER SYSTEM. Koch, F.; Znamirovschi, V. (Univ., Cluj). Stud. Cercet. Fiz.; 22: 689-91(1970). (In Rumanian).

The slow proton exchange becomes more rapid while the radiation dose increases. This fact appears first in the coalescence and after that in the narrowing of the only peak of the OH group and the water. Therefore the gamma rays have a catalytic action on the proton exchange. (auth)

21048 POST EFFECTS IN THE RADIOLYSIS OF POLYSTYRENE. Rosenberg, A.; Heusinger, H. (Technische Hoch-

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schule, Munich). Angew. Makromol. Chem.; 12: 185-96(Jun 1970). (In German).

In polystyrene the major portion of crosslinks is produced during irradiation in a "hot reaction." Ten percent of the crosslinks are formed in a postreaction. A kinetic analysis of the experimental data showed the latter reaction to be first order. At larger storage times especially at higher temperatures the initial increase of crosslinks is followed by a decrease. This can only be explained if the crosslinks are formed during dissolution. It is assumed that the posteffect is due to trapped cyclohexadienyl and benzyl radicals. First order kinetics is ascribed to a transformation of cyclohexadienyl to benzyl radicals. By dissolution of the polymer after increasing storage time the reaction of cyclohexadienyl radicals with benzyl radicals, which leads predominantly to disproportionation, is replaced by recombination of two benzyl radicals forming crosslinks. At higher temperatures and long storage times benzyl radicals disappear in the solid polymer but do not form crosslinks. Additives like anthracene and naphthoquinone suppress the posteffect. A reaction mechanism for the formation of crosslinks during γ irradiation and in the postreaction is proposed. (auth)

21049 ESR STUDY OF AN ACETYLENIC RADICAL IN TWO HOST CRYSTALS. X-IRRADIATED METHYL-2-NONYNOATE TRAPPED IN UREA AND PERHYDROTRIPHENYLENE INCLUSION CRYSTALS. Birrell, G. Bruce; Lai, Allen A.; Griffith, O. Hayes (Univ. of Oregon, Eugene). J. Chem. Phys.; 54: 1630-5(15 Feb 1971).

Single crystals of methyl- 2-nonynoate–urea and methyl- 2-nonynoate–perhydrotriphenylene inclusion compounds were x irradiated at 77°K and investigated by ESR at room temperature. The stable radical observed in both inclusion crystals is $CH_3(CH_2)_4\dot{C}H-C\equiv C-CO_2CH_3$. This radical exists in quite different conformations in the two host crystals. All spectra are well resolved and agree with computer-simulated spectra. A table of proton coupling constants and g values is given. (auth)

21050 ION–MOLECULE REACTIONS IN ALPHA-PARTICLE IRRADIATED NH_3, CD_4, AND D_2O. Fluegge, Robert A.; Landman, Donald A. (Cornell Aeronautical Lab., Inc., Buffalo). J. Chem. Phys.; 54: 1576-91(15 Feb 1971).

The time evolution of the various primary and secondary positive ion species formed in NH_3, CD_4, and D_2O gases bombarded by 1 to 3.5 MeV alpha particles was investigated. The measurements were made with a pulsed time-of-flight mass spectrometer at pressures in the 10 to 40 micron range. Ion–molecule reaction schemes are proposed, the data analyzed for self-consistency, and a variety of reaction rates deduced. Comparisons were made with other experiments in which electron bombardment was used for primary ionization. Results indicate the existence of a relatively long-lived [$\tau = 0.28(4)$ μsec] $(C_2D_7^+)^*$ ion complex formed from the reaction $CD_3^+ + CD_4$, paralleling previous results [R. A. Fluegge, J. Chem. Phys., 50: 4373(1969)] for the CH_4 system. (auth)

21051 ELECTRON SPIN RESONANCE OF GAMMA-RAY IRRADIATED SINGLE CRYSTALS OF SODIUM CHLORATE. Krasner, Saul. Brooklyn; Polytechnic Inst. of Brooklyn (1970). 92p. University Microfilms Order No. 70-26,072.

Thesis.

The radiation damage in sodium chlorate by electron spin resonance techniques was investigated. Large, clear crystals with no detected impurities of nuclear spin ½ were grown from aqueous solution by slow cooling. Sodium chlorate, a cubic structure belonging to space group $P(2_13)$, may be considered a distorted fcc lattice. When sodium chlorate is gamma or x irradiated, several ESR spectra appear. A sixteen-line spectrum attributed to $Cl-ClO_2^-$ is in any of twelve lattice sites with the principal magnetic axis in the $(\bar{1}10)$ plane at 30° to the unit cell edge. The data fit the axial spin-Hamiltonian $\mathcal{H} = \beta[g_{\parallel} H_z S_z + g_{\perp}(H_x S_x + H_y S_y)] + A_1 S_z I_{1z} + B_1(I_{1x} S_x + I_{1y} S_y) + A_2 S_z I_{2z} + B_2(I_{2x} S_x + I_{2y} S_y)$ with $g_{\parallel} = 2.0017 \pm 0.003$, $g_{\perp} = 2.0185 \pm 0.0005$, $A_1 = 92.8 \pm 0.3$ Gauss $B_1 = 19.1 \pm 0.8$ Gauss, $A_2 = 16.3 \pm 0.2$ Gauss and $B_2 = 1.2 \pm 1.0$ Gauss. A four-line spectrum attributed to ClO_2 in interstitial positions is described by the rhombic spin Hamiltonian $\mathcal{H} = \beta S \cdot g \cdot h + S \cdot A \cdot I$ with $g_{xx} = 2.0025 \pm 0.0003$, $g_{yy} = 2.0014 \pm 0.0003$, $g_{zz} = 2.0133 \pm 0.0004$, $A_{xx} = 70.7 \pm 0.3$ Gauss, $A_{yy} = 0.0 \pm 1.0$ Gauss and $A_{zz} = 14.5 \pm 1.0$ Gauss. The direction cosines of the x, y and z principal axes with respect to the crystal [100], [010], and [001] axes are respectively; x axis: +0.467, −0.524, +0.712; y axis: −0.783, −0.129, −0.608; z axis: +0.411, −0.842, −0.350. Eleven remaining orientations are generated by crystal symmetry. A second four-line spectrum that is almost isotropic is attributed to a nearly freely rotating ClO_2 in a ClO_3^- vacancy. Several lines centered at g = 2 cannot be explained. Annealing irradiated specimens reduces the intensity of all spectra with a single intense line appearing. This line is due to O_3^- rotating about the [111] axis in a ClO_3^- vacancy. It is axially symmetric and described by spin-Hamiltonian parameters $g_{\parallel} = 2.0080 \pm 0.0005$ and $g_{\perp} = 2.0119 \pm 0.0005$. (Diss. Abst., Int. B)

21052 γ-RADIOLYSIS OF LIQUID n-HEXANE. THE EFFECTS OF RADICAL, ELECTRON, AND POSITIVE-ION SCAVENGERS. Shinsaka, Kyoji; Shida, Shoji (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap., 43: 3728-40(Dec 1970).

The effects of various additives, SF_6, NH_3, C_2H_5OH, N_2O, NO, SO_2, and C_2H_4, on the product yields in the γ radiolysis of liquid n-hexane at room temperature were investigated. The following conclusions were drawn: (i) The added SO_2 acts mainly as a radical scavenger. (ii) The added NO shows not only the effect of radical scavenging, but also other effects. Therefore, it is inadequate to use NO as a simple radical scavenger. (iii) The C_7-C_{12} products are formed from a combination reaction of alkyl radicals, but not from an ion-molecule reaction. (iv) The formation of $C_6H_{13}^+$ ions by the direct action of radiation is suggested. (v) The G-value of ionization is evaluated to be 4.0. A brief discussion concerning the formation of N_2 in the presence of N_2O is also given. (auth)

21053 ESR STUDY OF INTERMEDIATES IN γ-IRRADIATED METHYLCYCLOHEXANE AND ISOBUTANE CONTAINING BENZENE. Wakayama, Terunobu; Miyazaki, Tetsuo; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap.; 43: 3761-5(Dec 1970).

Intermediates from benzene and toluene in γ-irradiated glassy methylcyclohexane (MCH) and polycrystalline isobutane matrices at 77°K were investigated. The γ irradiation of MCH containing low concentrations of benzene gave an ESR spectrum with a good hyperfine resolution, which can be ascribed to the benzene anion, while at higher concentrations of benzene it gave an ESR spectrum with a poor resolution, which is attributable to the benzene monomer and dimer anions. On the contrary, the γ irradiation of polycrystalline isobutane containing benzene did not yield an ESR spectrum which can be attributed to the benzene anion. However, the γ irradiation of a mixed glass of isobutane and 4 mol % MCH containing benzene gave an ESR spectrum which is attributable to the benzene anion. The yield of trapped electrons in this system was three times as large as that in pure γ-irradiated MCH. Such a difference in the results between glassy MCH and polycrystalline isobutane matrices gives evidence of a phase effect on the radiolysis of solid hydrocarbon. (auth)

21054 RADIOLYSIS OF LIQUID NITROGEN CONTAINING HYDROCARBONS. II. ACETONITRILE FORMATION FROM THE SOLUTION OF ETHYLENE. Oka, Takefumi; Sato, Shin (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 43: 3711-15 (Dec 1970).

The ^{60}Co γ radiolysis of liquid nitrogen containing ethylene was reinvestigated in order to elucidate the mechanism of the formation of nitrogenous products. When the conversion of ethylene was 10%, the G-values of hydrogen cyanide and acetonitrile were 0.21 ± 0.03 and 0.05 ± 0.01, respectively. The isotopic distributions in acetonitrile, n-butane, and acetylene were examined by using an equimolar mixture of C_2H_4 and C_2D_4 as the solute. From analysis of these distributions, it was concluded that acetonitrile is produced mainly from the reaction between nitrogen atoms and ethyl radicals. (auth)

21055 RADIOLYSIS OF POTASSIUM IODATE IN NEUTRAL AQUEOUS SOLUTIONS. Bhattacharyya, S. N.; Bardhan, D. K. (Saha Inst. of Nuclear Physics, Calcutta). Z. Phys. Chem. (Frankfurt); 72: 38-43(Nov 1970).

Aqueous solutions of potassium iodate in neutral medium were irradiated with ^{60}Co gamma rays. Iodide and elemental iodine were identified among the radioinduced decomposition products. The radiolytic yields, $G(-IO_3^-)$, $G(I_2)$, and $G(I^-)$ were determined. Effects of varying the solute concentration were also studied. A mechanism of reactions for the radiolysis is proposed and discussed. (auth)

21056 SEPARATIONS OF THE ABSORPTION AND EMISSION SPECTRA OF CERTAIN TRANSITIONS BY PULSED RADIOLYSIS AT LOW PRESSURE. Clerc, M.; Lesigne, B. (CEN de Saclay, Gif-sur-Yvette, France). Can. Spectrosc.; 16: 17-20(Jan 1971).

The simultaneous use of nanosecond pulsed radiolysis, and of a fast (rise time = 500 ns) shutter allows the separation of the emission and the absorption spectra in the following transitions: N_2^+ ($B\,^2\Sigma_u^+ \rightleftharpoons X\,^2\Sigma_g^+$), N_2 ($C\,^3\pi_u \rightleftharpoons B\,^3\pi_g$), CO_2^+ ($A\,^2\pi_u \rightleftharpoons X\,^2\pi_g$). Some of the absorptions mentioned were observed here for the first time. Advantages of pulsed-radiolysis in low pressure conditions are discussed. (auth) (Canada)

21057 ELECTRON SPIN RESONANCE SPECTRA OF IRRADIATED 2-METHYLTETRAHYDROFURAN GLASS. Shiga, Tetsuo; Warashina, Tetsuo; Yoshida, Hiroshi; Okamura, Seizo

(Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 19-23(1970).

Electron spin resonance spectra of 2-methyltetrahydrofuran glass were studied after the irradiation with γ rays at 77°K. The observed signal is composed of a singlet spectrum and a septet spectrum, which were attributed to trapped electrons and free radicals formed by removal of a tertiary hydrogen from the glass matrix molecules, respectively, and also of an unresolved broad singlet spectrum with the width (ΔH_{ms}) of 13.5 G that was not previously reported. This spectrum disappears concomitantly with the trapped electron spectrum, when the latter is bleached by light. However, it is evidently distinguished from the trapped electron spectrum by the difference in their microwave power saturation phenomena. These observations lead to a tentative assignment that the new spectrum is due to cation radicals by removal of an electron from the matrix molecules that recombine with the trapped electrons. (auth)

21058 IONIC PROCESSES IN IRRADIATED ALKANE GLASSES. Yoshida, Hiroshi (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 153-61(1970).

Electron spin resonance studies were made on ionic processes in 3-methylpentane and 3-methylhexane glasses irradiated by gamma rays. The mechanism of electron trapping, the moving entity in the charge recombination process, and the possibility of the observation of cationic intermediates in these glasses are discussed. The behavior of the trapped electrons led to a working hypothesis that two kinds of trapped electrons are involved. Electrons are trapped in matrix traps as well as in traps due to impurity molecules in the glasses. The electrons in the matrix traps migrate in the glasses rather rapidly to recombine with cations, whereas the slow migration of the cations causes the decay of the electrons in the impurity traps. The electron traps are cavities surrounded preferably by carbon atoms rather than by hydrogen atoms of alkane molecules. Cations trapped in the glasses are electron deficient holes (cation radicals of alkane molecules), which are observed in the electron spin resonance spectra of irradiated glasses. (auth)

Radioisotope Production

Refer also to abstract 21100.

21059 (JAERI-Memo-4220) PRODUCTION OF ^{197}Hg AND ^{203}Hg. II. DEVELOPMENT OF PRODUCTION TECHNIQUES. Yamabayashi, Hisamichi; Onoma, Kathuyuki; Motoishi, Shoji (Japan Atomic Energy Research Inst., Tokyo). Oct 1970. 42p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Procedures are described for post-irradiation treatment for production of purified mercury radioisotopes (^{197}Hg and ^{203}Hg) from mercury(II) oxide. Tools were devised for opening aluminum and stainless steel capsules and quartz ampoules. Chemical treatment of irradiated mercury(II) oxide with hydrochloric or nitric acid was studied together with the vaporization of the radioactive mercury salts when the latter were evaporated to dryness. The method suitable for routine absolute measurement was established and the radiochemical purity of both ^{197}Hg and ^{203}Hg was determined. On the basis of results obtained, equipment for ^{197}Hg and ^{203}Hg production was designed and constructed in a movable innerbox provided with lead shield 50 mm thick, and test and practical production runs were carried out. The activity concentrations in the air of the operating and servicing area and also in the exhaust air from the stack during the production were not more than the detective level, 10^{-12} μCi/cc. About 90% of the ^{197}Hg and ^{203}Hg, of which specific activities were 3×10^3 mCi/g Hg and 120 mCi/g Hg respectively, was recovered as $HgCl_2$ in 1N ± 50% hydrochloric acid solution and their radiochemical purity was higher than 99% (^{197}Hg included 2 ~ 3% ^{203}Hg). (auth) (Japan)

21060 AMERICAN INVESTIGATIONS IN THE FIELD OF THE FAR ACTINIDES. Spitsyn, V. I. Radiokhimiya; 12: 635-49 (1970). (In Russian).

Production and separation methods, as well as investigations on the properties of the far actinides, are reviewed. (J.G.B.)

21061 CYCLOTRON PRODUCTION OF CARRIER-FREE ^{67}Ga. Silvester, D. J.; Thakur, M. L. (Hammersmith Hospital, London). Int. J. Appl. Radiat. Isotop.; 21: 630-1(10 Oct 1970).

The disadvantages of the method, described by Hupf and Beaver (Int. J. Appl. Radiat. Isotop., 21: 75(1970)), of ^{67}Ga production by bombarding a zinc target with a 21-MeV proton beam are discussed. An alternative method using copper as the target material and a 30-MeV α-beam is described, the relative yields quoted, and the method of subsequent separation of carrier-free ^{67}Ga given. (UK)

21062 PRODUCTION OF CARRIER-POOR ^{56}Mn FROM NEUTRON-IRRADIATED Mn DECACARBONYL. Reichold, P.; Wolf, P. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Radiochim. Acta; 15: 1-2(Jan 1971). (In German).

A method of enrichment of ^{56}Mn by the Szilard–Chalmers reaction in neutron-irradiated $Mn_2(CO)_{10}$ is described. ^{56}Mn in the divalent form was separated by extraction or sublimation. Particularly good enrichment factors were obtained with sublimation because, in the case of extraction, there is already a photochemical decomposition of the dissolved $Mn_2(CO)_{10}$ in the daylight. (auth)

21063 MEASUREMENT OF THE EXCITATION FUNCTIONS OF (d,x) REACTIONS ON ^{59}Co. Bilabel, R. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Radiochim. Acta; 15: 13-17(Jan 1971). (In German).

Excitation functions for the production of ^{57}Ni, ^{60}Co, ^{58}Co, ^{57}Co, ^{56}Co, ^{59}Fe, ^{56}Mn, ^{54}Mn, and ^{51}Cr by irradiation of ^{59}Co with deuterons were measured, with single foils and a stacked foil arrangement, in the energy range from 20 to 52 MeV. The beam current of the incident deuterons of the Karlsruhe Isochronous Cyclotron was determined with aluminum monitor foils using the reaction ^{27}Al(d,pα)^{24}Na. The error in the absolute cross section scale was estimated as 15%. (auth)

21064 ^{53}Mn PRODUCED BY 730 MeV PROTON BOMBARDMENT OF IRON. Matsuda, Hideki (Kyushu Univ., Fukuoka); Umemoto, Shunji; Honda, Masatake. Radiochim. Acta; 15: 51-3 (Jan 1971).

An iron target was bombarded by 730-MeV protons in a cyclotron. After nine years, the manganese was chemically separated and the ^{54}Mn activity was measured. The ^{53}Mn activity was determined using a neutron activation technique. Using the ratio of the initial ^{53}Mn and ^{54}Mn activities after the iron target bombardment and the corresponding ratio of these activities as measured in several meteorites, a half-life of $(2.9 \pm 1.2) \times 10^6$ years for ^{53}Mn was calculated. (auth)

Recoil Production and Reactions

Refer also to abstract 22962.

21065 (NYO-2771-40) NUCLEAR CHEMISTRY RESEARCH, Annual Report, January 1970–December 1970. Wolke, Robert L. (Pittsburgh Univ., Pa. Wherrett Lab. of Nuclear Chemistry). Contract AT(30-1)-2771. 36p. Dep. NTIS.

The charge states of recoils from nuclear reactions were studied and data were amassed on the angular distributions of the elastic ^{10}B(d,d)^{10}B and ^{11}B(d,d)^{11}B reactions. Developments are also reported in the production of ultrathin targets needed in the charge-state work. Recoils from ^{12}C(d,d)^{12}C, ^{12}C(d,α)^{10}B, ^{10}B(d,d)^{10}B, and ^{11}B(d,d)^{11}B reactions were investigated. (M.C.G.)

21066 HOT ATOM CHEMISTRY OF ^{13}N RECOIL ATOMS IN NH_3, NH_4F, $NH_4F.HF$, $N_2H_4.2HF$, $NH_2OH.HCl$, AND NaN_3. Schats, J. J. C.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta; 15: 46-51(Jan 1971).

Recoil reactions of ^{13}N atoms produced by (n,2n) and (γ,n) reactions were studied in several solid inorganic nitrogen compounds. The yields of $^{13}NH_4^+$, $H_2{}^{13}NNH_2$, ^{13}NN, and, where necessary, $^{13}NN_2^-$ and ^{13}NNO were determined. Except in the case of the active products in NH_4F HF, the various radioactive species studied showed little or no annealing effects up to a temperature of +70°C. (auth)

21067 REACTIONS OF NUCLEOGENIC HALOGEN ATOMS IN LIQUID HALOBENZENES. (RECOIL HALOGENATION III). Berei, Klara; Stoecklin, G. (Kernforschungsanlage, Juelich, Ger.). Radiochim. Acta; 15: 39-46(Jan 1971).

Hydrogen and halogen substitutions by recoil chlorine, bromine, and iodine, produced via (n,γ) and (n,2n) reactions were studied in the four liquid monohalobenzenes. Comparison between (n,γ)- and (n,2n)-produced recoil halogen in unscavenged C_6H_5Cl and C_6H_5I shows that the halogen replacement yields are considerably higher in case of the (n,γ)-reaction for both recoil chlorine and iodine. In the presence of 1 mole % I_2-scavenger, however, the difference between (n,γ) and (n,2n) reactions completely disappears. Scavenger and competition experiments were carried out to obtain further information on the yield-determining factors in hot halogen replacement. It could be shown that the halogen replacement yield for recoil bromine and iodine is proportional to the geometrical cross section and energy loss for the halogen-halogen collision and inversely proportional to the C-halogen bond energy. The results are explained on the basis of one-step replacement reactions and immediate caged radical combinations following a hot displacement. As in the case of recoil chlorine, hydrogen substitution by recoil bromine and iodine shows little or no selectivity and reactivity effects. The o-, m-, p-isomer distribution remains

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practically unchanged when comparing (n,γ) and (n,2n) reactions. In each case almost statistical isomer distribution is observed with a slight deviation in the m- and p-position. The results are explained on the basis of a hot homolytic aromatic substitution proceeding via a first formed π-complex. (auth)

21068 HOT ATOM CHEMISTRY OF PERFLUOROCARBONS. van Dulmen, A. A.; Aten, A. H. W. Jr. (Inst. for Nuclear Physics Research, Amsterdam). Radiochim. Acta; 15: 34-9(Jan 1971).

By means of the nuclear reactions $^{19}F(n,2n)^{18}F$ and $^{19}F(\gamma,n)^{18}F$ the following materials were activated: n-perfluorohexane, perfluorobenzene, perfluorotoluene, perfluorocyclohexene, perfluorocyclohexane, and perfluoro(methyl)cyclohexane. A large number of ^{18}F-compounds was formed, but, except in the case of C_6F_{14}, most of the radioactive products could not be recognized. In some cases the difference between the results in the solid and the liquid phase or between the two different nuclear reactions was observed. A comparison was made between the chemical behavior of ^{18}F in fluorocarbon systems and that of T in hydrocarbons. (auth)

21069 CHLORINE HOT ATOM CHEMISTRY IN PERCHLOROCARBON COMPOUNDS. van Dulmen, A. A.; Aten, A. H. W. Jr. (Inst. for Nuclear Physics Research, Amsterdam). Radiochim. Acta; 15: 26-33(Jan 1971).

The compounds CCl_4, C_2Cl_4 and C_2Cl_6 were activated by means of the nuclear processes $^{35}Cl(n,2n)^{34m}Cl$ and $^{37}Cl(n,\gamma)^{38}Cl$. The distribution of radioactive chlorine was determined over the following fractions: inorganic chlorine, CCl_4, C_2Cl_4, C_2Cl_6, C_4Cl_6, compounds of the type C_3Cl_x, and polymer. The influence of the type of nuclear reaction, the nature of the phase of the target material, the neutron flux, and the presence of scavengers were studied. The behavior of radioactive chlorine atoms in perchlorocarbon compounds was compared to that of tritium in hydrocarbons. (auth)

21070 CHEMICAL EFFECTS OF THE $^{37}Cl(n,\gamma)^{38}Cl$ PROCESS IN BINARY MIXTURES OF CHLOROBENZENE WITH PARAFFINS AND ALCOHOLS. Kontis, S. S.; Urch, D. S. (Democritus Nuclear Research Centre, Attikis, Greece). Radiochim. Acta; 15: 21-6(Jan 1971).

The reactions of recoil chlorine-38 atoms produced by the $^{37}Cl(n,\gamma)^{38}Cl$ reaction in the following binary mixtures (i) chlorobenzene + methanol, ethanol, n-hexanol, n-heptanol, n-octanol, benzyl alcohol and (ii) chlorobenzene + benzene, n-hexane, n-heptane, n-octane, n-nonane, n-decane, and cyclohexane, at various compositions were studied. Except in the case of benzene, the organic yield falls quite sharply for low concentrations of alcohol or hydrocarbon and then much more slowly for higher concentrations of alcohol or hydrocarbon, from 61% in pure chlorobenzene to between 3 and 16%, extrapolated to zero chloride concentration. The chlorobenzene–benzene system behaves differently. As the amount of benzene increases, the organic yield falls very slowly until the mole fraction of benzene exceeds 0.8. Then the organic yield falls sharply to about 25% (extrapolated) at zero chlorobenzene concentration. The possible processes responsible for the stabilization of ^{38}Cl in organic form are discussed. (auth)

21071 CHEMICAL BEHAVIOR OF RECOIL ATOMS PRODUCED BY VARIOUS NUCLEAR PROCESSES IN METAL PHTHALOCYANINE COMPLEXES. Yang, Mo-hsiung; Yoshihara, Kenji; Shibata, Nagao (Japan Atomic Energy Research Inst., Tokai). Radiochim. Acta; 15: 17-20(Jan 1971).

A systematic study of the relative importance of the effect of charge and kinetic energy on the chemical fate of recoil atoms was undertaken in some metal phthalocyanine complexes. For the isotope effect of ^{65}Zn and ^{69m}Zn (produced by n,γ reactions) it was shown that the contribution of rupture by high charge based on internal conversion of γ rays and the subsequent Auger effect was small and the difference in kinetic energy was the main factor. The influence of kinetic energy on the retention showed a similar tendency in Zn, Ni, and Co complexes. In the case of the decay $^{57}Ni \rightarrow {}^{57}Co$, on the other hand, the retention in the complex seems to be mainly determined by the effect of the Auger process. (auth)

21072 OXYGEN EFFECT IN THE ANNEALING OF RECOIL ATOMS IN POTASSIUM CHROMATE. Podeanu, G.; Costea, T. (Inst. of Atomic Physics, Bucharest). Radiochem. Radioanal. Lett.; 6: 57-61(10 Feb 1971).

At temperatures higher than 180°C, the retention in potassium chromate is greater when the irradiation and heating are performed in an inert gas atmosphere than for the experiments in air. It seems that the oxygen effect depends on the pretreatment of the sample. (auth)

21073 STUDY ON RECOIL PRODUCTS OF INORGANIC PHOSPHORUS OXYACIDS. II. SEPARATION OF RECOIL PRODUCTS BY PAPER ELECTROPHORESIS USING BACKGROUND BUFFER SOLUTIONS CONTAINING ZINC OR CALCIUM IONS. Kitaoka, Yoshinori; Takada, Jitsuya; Kobayashi, Mitsue; Kiso, Yoshiyuki (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 32-8(1970).

Hypophosphite, phosphite, hypophosphate, phosphate, and pyrophosphate were irradiated at reactor temperature in the KUR, and the resulting ^{32}P-labeled recoil products were analyzed by paper electrophoresis. In order to improve the resolution, the complex formation reaction of phosphorus oxyacids with zinc or calcium ions was utilized. The concentration of the metallic ions or the pH value of the background buffer solution affected the mobility of the recoil products. The analysis of the electrograms allowed many of the recoil products to be identified. The oxidation state of the phosphorus atom in the target material influenced the distribution of recoil products strongly too. That large amounts of reduced recoil products as found in lower temperature irradiation could not be found indicates that the primary recoil products are annealed into more stable compounds during irradiation or/and cooling. (auth)

21074 STUDY ON RECOIL PRODUCTS OF INORGANIC PHOSPHORUS OXYACIDS. I. PAPER CHROMATOGRAPHIC SEPARATION OF RECOIL PRODUCTS WITH VARIOUS SOLVENTS. Kitaoka, Yoshinori; Kawamoto, Keizo; Kobayashi, Mitsue; Kiso, Yoshiyuki. (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 24-31(1970).

Hypophosphite, phosphite, hypophosphate, phosphates, and pyrophosphate were irradiated with thermal neutrons (5×10^{12} n/cm^2 · sec) at reactor temperature. The irradiated phosphorus oxyacids were separated by paper chromatography. Neutral, basic, and acid solvents were used in an ascending method. The radiolysis products were detected by Hanes and Isherwood's reagent. The inconsistency among results obtained from different solvents seems to depend on the specific nature of the recoil products. If the irradiated hypophosphite was developed by a two-dimensional paper chromatography, an unusual result was obtained. (auth)

21075 CHEMICAL REACTIONS OF HIGHLY ENERGETIC TRITIUM RECOIL ATOMS WITH LIQUID CYCLOHEXENE. PART I. EXPERIMENTAL RESULTS AND DISCUSSION OF INTERMOLECULAR TRITIUM DISTRIBUTION. Bieler, H.; Battig, F.; Jordan, P. (Eidgenoessische Technische Hochschule, Zurich). Z. Phys. Chem. (Frankfurt); 72: 1-22(Nov 1970). (In German).

Cyclohexene was exposed to tritium recoil atoms by neutron irradiation in a reactor in the presence of lithium carbonate. The intermolecular distribution of the tritium was analyzed by radiogas chromatography and mass spectrometry. The relative contributions of thermal and nonthermal tritium reactions were determined. Values of 1 : 0.81 : 0.64 were found for the relative activities per hydrogen atom in the α, β, and γ positions. The chief reaction mechanisms are discussed. (tr-auth)

Radiochemistry

Refer also to abstracts 20998, 21233, 21530, and 21531.

21076 (NAS-NS-3034(Rev.)) RADIOCHEMISTRY OF TITANIUM. Landis, Vincent J.; Kaye, James H. (National Academy of Sciences-National Research Council, Washington, D. C. Committee on Nuclear Science). Jan 1971. 91p. Dep. NTIS.

The inorganic chemistry of titanium, hazards and precautions in handling titanium-containing materials, counting techniques, and radiochemical separation procedures are discussed. 156 references. (M.C.G.)

Separation Processes

Refer also to abstracts 20919, 20937, 20963, 20964, 21000, 21060, 21076, 21253, 21268, 21272, 21347, 21356, 21359, 21365–21367, 21369, 21371, 21374, 21686, and 23047.

21077 (BNWL-1544) ION EXCHANGE TREATMENT OF B PLANT PROCESS CONDENSATE. Mercer, B. W.; Adams, J. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1970. Contract AT(45-1)-1830. 32p. Dep. NTIS.

Laboratory experiments were conducted to evaluate ion exchange treatment of B Plant process condensate. Ion exchange was found to be effective for removing the principal radionuclides providing the condensate was steam stripped to remove ammonia. The cation and anion exchange resins must be used in the H^+ and OH^- form, respectively, for satisfactory removal of all radionuclides. The presence of Ca^{2+} and Mg^{2+} in the condensate limits the volume put through the ion exchange beds to ^{137}Cs breakthrough if the ammonia is reduced to near 0 mg/liter. (auth)

21078 (CONF-700816-(Vol.2), pp 568-80) INORGANIC ADSORBER MATERIALS FOR TRAPPING OF FISSION PRODUCT IODINE. Wilhelm, J. G.; Schuettelkopf, H. (Kernforschungszentrum, Karlsruhe (West Germany)).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

Experimental work was performed to evaluate the usefulness of inorganic adsorber materials for iodine filtering devices. Special interest was concentrated on materials for off-gas cleaning in fuel reprocessing plants and gas cleaning inside the reactor containment under MCA conditions. Considering the high price of silver and the sensitivity of molecular sieves for acids, new inorganic adsorber materials were developed with relatively low silver loadings and high removal efficiencies for methyl iodide and iodine. Experimental data are given for the removal efficiencies of new inorganic adsorber materials in wet air and superheated steam; besides, experiments are reported to evaluate the effect of nitrogen oxides on the performance of the adsorber materials. The efficiencies and the prices of the new materials are compared with those of silver impregnated molecular sieves. (auth)

21079 (IAEA-R-712-F) DEVELOPMENT OF SAFEGUARDS PROCEDURES FOR A REPROCESSING PLANT SIMILAR TO THE WAK TYPE. Gupta, D.; Haefele, W. (International Atomic Energy Agency, Vienna (Austria)). Feb 1970. 59p. NTIS (U. S. Sales Only).

After a detailed analysis of the WAK plant layout and process steps as well as demarcation of the plant operation and areas relevant to a rational safeguards system, the strategic areas in the plant were defined. At these areas all the information required for safeguards purposes can be obtained in a nonintrusive manner and without hampering the normal operation of the plant. The detailed safeguards measures at these strategic areas were developed and the procedures for carrying out these measures laid out. The error propagation mechanism, after taking into consideration both the random and the systematic components of measurement error, was analyzed and its influence on the establishment of a material balance shown with the help of a numerical example. An effort was also made to estimate the costs to be expected for the safeguards system proposed in this report. It is shown that they may be about 3% of the reprocessing costs from the plant. Chemical analyses form a major part of the total costs. Means of reducing these costs are discussed. A number of possible improvements with regard to safeguards methods, instruments, and techniques are discussed. Some estimates on the development time and efforts were also made. Besides, some relevant features in a reprocessing plant, which may be of interest for safeguards, are described with the help of a reference plant layout. (auth) (INIS)

21080 (INIS-mf-4) RARE METALS EXTRACTION IN INDIA. Sundaram, C. V.; Saratchandran, N. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 1970. 56p. (CONF-700218-18). NTIS (U. S. Sales Only).

From Symposium on materials science research; Bangalore, India (24 Feb 1970).

Achievements to date and the current status in the extraction and refining of rare and reactive materials in India are surveyed. Abundant significant raw material reserves are available and processes were developed for (i) the physical and chemical beneficiation of beach sand minerals and other ore deposits, to produce concentrates, (ii) ion exchange and solvent extraction for separation of similar elements, for attainment of very high levels of purity, (iii) chlorination and hydrofluorination of metal oxides, to produce the anhydrous halides (in packed and fluidized beds), (iv) metallothermic reduction of halides and oxides, to produce metals in ingot, sponge and powder form, (v) fused salt electrolysis, (vi) induction melting, consumable electrode arc melting, electron beam melting and refining, and (vii) ultrapurification by chemical transport techniques and zone refining. Based on pilot plant operating experience, tonnage plants were designed and are under erection/operation for the production of high-purity Zr (and Hf), U, Pu, Th, and on a smaller scale, Ta, Nb, W, and Ti. (INIS)

21081 (KFK-1104) VERIFICATION OF INPUT ANALYSIS OF A REPROCESSING PLANT BY MEANS OF COMPOSITE SAMPLE TECHNIQUE. Avenhaus, R.; Beyrich, W.; Koch, L.; Kraemer, R.; Thiele, D.; Wertenbach, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Nov 1970. 57p. (EUR-4570). Dep. NTIS (U. S. Sales Only).

In batchwise dissolution of reactor fuel elements, to establish material balance all input batches have to be sampled and analyzed separately. This results in high analytical costs. As only the sum of these data is finally interesting, for verification, the composite sample technique, analyzing only one representative mixed "composite" sample from the input batches, may be applied. A remote, motor-driven 2 ml burette was taken for pipetting the variable volumes, v_i, of aliquots. Input accountability during a safeguards experiment in a commercial reprocessing plant by means of composite sample technique showed a difference of 2.5% both for uranium and plutonium compared with the accountability based on single batch analyses. The inclusion of x-ray fluorescence spectrometry decreased the difference to 2% for uranium and increased the difference to 3% for plutonium. As all the values of the uranium and plutonium concentrations determined by the composite sample technique are higher than those calculated from single batch analyses, it is indicated that these differences cannot be explained by random errors only. These higher concentrations may be caused, for instance, by autoradiolysis. A detailed error analysis for the single batch analyses method as well as the composite sample technique is given. (auth)

21082 (KFK-1107) DESIGN CRITERIA FOR REPROCESSING PLANTS. Hagen, A.; Herre, F.; Gupta, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Nov 1970. 17p. Dep. NTIS (U. S. Sales Only).

Analysis of an existing reprocessing plant, the Wiederaufarbeitungsanlage Karlsruhe (WAK), showed that the major bulk of information relevant to safeguards is transferred by an extended network system prior to reception at different places in the plant. Efforts to guarantee the correctness of the information are required. Criteria were developed for a plant design at which the generation and reception of the essential information are restricted to uniform area and for which a reduction of the safeguards costs can be expected. The principal arrangement of such a plant is given. (auth)

21083 (MLM-1767) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT: JULY–SEPTEMBER 1970. (Mound Lab., Miamisburg, Ohio). 5 Mar 1971. Contract AT-33-1-GEN-53. 22p. Dep. NTIS.

Topics covered include: ^{229}Th recovery, ^{230}Th and protactinium contents of airport cake residues, instability of heptavalent Pu in water solutions, liquid scintillation counting of ^{238}Pu, preparation of tritiated hydrogen gas standards, and x-ray fluorescence of thorium oxide–uranium oxide samples. (M.C.G.)

21084 (SRARI-P-75) ION EXCHANGE BEHAVIOR OF AMERICIUM, CURIUM, AND PROMETHIUM TRIVALENT IONS WITH THE PRESENCE OF EDTA. Elesin, A. A.; Zaitsev, A. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1970. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

The complexing of trivalent americium, curium, and promethium ions with ethylenediaminetetraacetic acid (EDTA) was investigated on the KY-2 cation exchanger in dynamic conditions. The buffer solution of ammonium α2-methyllactate served as a background electrolyte in contrast to the strong electrolytes usually used. The values obtained for the stability constants of americium, curium, and promethium complexes at an ionic strength of 0.1 are 17.14, 17.29, and 16.75, respectively. These data allow results of potentiometric determinations of stability constants of rare earth complex to be coordinated with the results of transplutonium element ion exchange separations. (auth)

21085 SYNTHESIS AND ION-EXCHANGE CHARACTERISTICS OF STANNIC MOLYBDATES: SEPARATION OF Fe^{3+} FROM Al^{3+}, Ni^{2+}, AND Mn^{2+} AND OF Ce^{3+} FROM Pr^{3+} AND Nd^{3+}. Qureshi, Mohsin; Husain, Khadim; Gupta, Jai Prakash (Aligarh Muslim Univ., India). J. Chem. Soc., A; No. 1, 29-32(1971).

Three new samples of stannic molybdate with Sn : Mo ratio of 2 : 1 were synthesized by mixing 0.1M $SnCl_4$ and 0.1M Na_2MoO_4 solutions in the volume ratios 2 : 1 (sample 1), 4 : 3, and 1 : 1 at pH 1. They are amorphous, monofunctional ion exchangers with an ion exchange capacity of ca. 0.54 to 0.73 mequiv g^{-1}. The K_d values of 25 cations were determined on these samples in aqueous medium. Sample 1 was found to be the most stable and K_d values on this sample were determined at pH 1, 2, 3, and 4. The selectivity of metal ions was also tested on this sample in the presence of 0.01 to 0.5M ammonium chloride. The analytical importance of these samples was established by some useful separations. (auth) (UK)

21086 CRAIG-DISTRIBUTION OF RARE EARTH NITRATES IN THE SYSTEM TRI-N-BUTYL PHOSPHATE–HNO_3. I. SEPARATION OF CERIUM EARTH MIXTURES. Rossmanith, K. (Univ., Vienna). Monatsh. Chem.; 101: 1665-71(Nov-Dec 1970). (In German).

The fractionation of cerium group rare earth mixtures was studied from a preparative point of view using fractional distribu-

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tion between HNO_3 and tri-n-butyl phosphate in a Craig apparatus (40 and 60 stages, respectively). When processing about 50 g and using the unsymmetrical double withdrawal method, up to 50% of the input could be extracted in a purity of better than 90 and 99%, respectively. The influence of certain variables on fractionation is discussed. (auth)

21087 DISTRIBUTION OF U(IV) BETWEEN TRI-N-BUTYL PHOSPHATE AND AQUEOUS NITRIC ACID. Schmid, Erich R. (Univ., Vienna). Monatsh. Chem.; 101: 1330-8(Sep-Oct 1970). (In German).

The distribution ratios of U(IV) in small concentrations between aqueous nitric acid and undiluted tri-n-butylphosphate phases were determined. U(IV) can well be extracted from aqueous nitric acid solutions. The ratio of distribution increases up to nitric acid concentrations 8n in the aqueous equilibrium phase, passes through a maximum between 8n to 9n and decreases again. Some factors of possible importance for the shape of the curve are being discussed briefly. (auth)

21088 DETERMINATION OF THE DISTRIBUTION RATIOS OF URANIUM(IV) BY MEANS OF EXTRACTION CHROMATOGRAPHY IN THE SYSTEM: UNDILUTED TRI-N-BUTYL PHOSPHATE–AQUEOUS NITRIC ACID. Schmid, Erich R. (Univ., Vienna). Monatsh. Chem.; 101: 1856-60(Nov-Dec 1970). (In German).

The distribution ratio of U(IV), $D_{U(IV)}$, between undiluted tri-n-butyl phosphate and aqueous nitric acid was determined by means of extraction chromatographic columns. The separation factor, β, of U(VI) and U(IV) (defined as the ratio of the distribution ratios, D, $\beta = D_{U(VI)}/D_{U(VI)}$ was obtained experimentally via the retention volumes. $D_{U(VI)}$ is known from the literature and $D_{U(IV)}$ was calculated. The $D_{U(IV)}$-values agree with those obtained by batch experiments, the reproducibility was even better. The stability of U(IV) in the chromatographic columns is good. In the very rare cases, in which U(IV) was oxidized to U(VI) during the experiment, this can be recognized from the shape of the elution curve, because the U(IV) peak shows a tailing. As long as the U(IV) peak is visible, even these experiments can be evaluated which was not possible in batch experiments. (auth)

21089 EVALUATION OF THE RATE OF REACTION OF ZIRCONIUM WITH D_2EHPA. Yagodin, G. A.; Tarasov, V. V. Radiokhimiya; 12: 666-8(1970). (In Russian).

Studies on the kinetics of the extraction of Zr from nitric acid solutions using bis(2-ethylhexyl) phosphate (D2EHPA) were continued. The formation of insoluble zirconium bis(ethylhexyl) phosphates resulting from ionic interactions takes place rapidly, and was studied using a special jet apparatus and extinguishing solution of EDTA. High values of the rate constant of the chemical interaction confirm the diffusion character of mass transfer in the extraction of Zr. (J.G.B.)

21090 RATE OF EXTRACTION OF ZIRCONIUM BY BIS(2-ETHYLHEXYL) PHOSPHATE FROM NITRATE MEDIA. Yagodin, G. A.; Tarasov, V. V. Radiokhimiya; 12: 664-6(1970). (In Russian).

Kinetics of the extraction of Zr using bis(2-ethylhexyl) phosphate (D2EHPA) were studied. The surface of phase contact ($a, m^2/m^3$) was followed according to the light scattering of emulsions, while the zirconium concentration in the aqueous phase was followed during the process of mass transport by analyzing samples collected after definite time intervals. Decane, carbon tetrachloride, chloroform, benzene, octane, and decanol were used as diluents. Results indicate that the reaction of Zr with D2EHPA occurs in the aqueous phase, and the total rate of extraction is determined by the step of transfer of the extraction reagent into the reaction phase. The rate of extraction can be calculated from data on the coefficients of mass removal of D2EHPA in the limiting (aqueous) phase. (J.G.B.)

21091 EXTRACTION SEPARATION OF THE ALKALINE EARTH FROM THE RARE EARTH ELEMENTS. Govbenko, F. P.; Kuchkina, E. D.; Olevinskii, M. I. Radiokhimiya; 12: 661-4 (1970). (In Russian).

The extraction of a mixture of alkaline earth metals from acid medium in the form of thiocyanate complexes with tributyl phosphate was studied. The optimum conditions of extraction were studied. The possibility of extraction of a mixture of the alkaline earth elements from acid solutions of the rare earth elements in the presence of complexone III as the masking agent was studied. The method can be used for the separate determination of alkaline earths after their separation. (auth)

21092 CONCENTRATION OF WASTES FROM RADIOCHEMICAL INVESTIGATIONS AND PURIFICATION OF WASTE WATER FROM RADIOACTIVE ELEMENTS WITH DIANTIPYRYLMETHANE. Zhivopistsev, V. P.; Petrov, B. I.; Ponosov, I. N. Radiokhimiya; 12: 631-5(1970). (In Russian).

The high effectiveness of diantipyrylmethane as an extraction reagent in a thiocyanate system and the possibility of using it for the extraction of radioactive elements, their separation and production in pure form (without a carrier) were demonstrated with radioactive cobalt (^{60}Co) as an example. A method was developed for the isolation of radioactive cobalt and other elements capable of forming sufficiently strong metal—thiocyanate complex anions (tin, iron, zinc, molybdenum, zirconium) from aqueous solutions, accumulated in the process of radiochemical investigations. (tr-auth)

21093 CHROMATOGRAPHIC SEPARATION OF ELEMENTS OF THE FIRST GROUP ON SILICA GEL. Mal'tseva, N. S.; Sheglovski, Z. Radiokhimiya; 12: 622-6(1970). (In Russian).

The cations of ^{22}Na, ^{86}Rb, ^{134}Cs, ^{212}Fr and ^{223}Fr were separated on brand KSK-2 silica gel. Distribution coefficients of Na, Rb, and Cs were determined as a function of the ammonium nitrate concentration and the hydrogen ion concentration. The ability of the cations to be retained on silica gel increased in the series Na < Rb < Cs < Fr, which is characteristic of the usual ion exchange. Chromatographic separation on silica gel can be used to obtain concentrated solutions of the alkali metals without a carrier in small volumes. The method developed for the separation of the alkali elements is rapid and convenient in comparison with other methods. (auth)

21094 INFLUENCE OF THE NATURE OF THE DILUENT AND THE STRUCTURE OF THE AMINE ON THE SELECTIVITY OF EXTRACTION. Shmidt, V. S.; Mezhov, E. A.; Shesterikov, V. N. Radiokhimiya; 12: 590-3(1970). (In Russian).

A number of extraction systems are given as examples to show that the selectivity of the extraction of metal salts by amine salts increases with decreasing values of BP, a parameter characterizing the ability of the diluent to solvate the anions of the amine salt, and with increasing values of σ, characterizing the inductive effects of the substituents contained in the molecule of the amine. It was also shown for the extraction of zinc-65 from HCl solutions that an increase in the ability of the diluent to solvate the anions of the amine salt has an equalizing effect on the ability of salts of amines of various structures to extract salts of metals. (tr-auth)

21095 ADSORPTION OF EASILY HYDROLYZED ELEMENTS BY SILICA GEL. IV. ADSORPTION OF TANTALUM FROM SOLUTIONS OF MINERAL ACIDS. Tsaletka, R. Radiokhimiya; 12: 558-64(1970). (In Russian).

A detailed study was made of the adsorption of tantalum on hydrated and silicone-coated silica gel as a function of the concentration of $HClO_4$, HNO_3, HCl, and H_2SO_4. The influence of the method of preparation and the age of the initial solutions on the kinetics of the adsorption of tantalum from hydrochloric acid was studied. (tr-auth)

21096 ADSORPTION OF EASILY HYDROLYZED ELEMENTS BY SILICA GEL. III. ADSORPTION OF NIOBIUM FROM SOLUTIONS OF MINERAL ACIDS. Tsaletka, R. Radiokhimiya; 12: 554-8(1970). (In Russian).

The adsorption of niobium on hydrated and silicone-coated silica gel as a function of the concentration of $HClO_4$, HNO_3, HCl, and H_2SO_4 within the range 1 to 10 g-eq/liter was studied. The most probable mechanism of capture consists of the adsorption of mixed neutral complexes of niobium. The results obtained were compared with the literature data on the state of aqueous solutions of niobium. (tr-auth)

21097 ADSORPTION OF EASILY HYDROLYZED ELEMENTS BY SILICA GEL. II. ADSORPTION OF ZIRCONIUM AND HAFNIUM ON SILICONE-COATED SILICA GEL FROM SOLUTIONS OF MINERAL ACIDS. Tsaletka, R. Radiokhimiya; 12: 549-54 (1970). (In Russian).

A study was made of the adsorption of zirconium and hafnium on silicone-coated silica gel as a function of the concentration of $HClO_4$, HNO_3, HCl, and H_2SO_4. It was found that in solutions with acid concentrations < 4 M (with the exception of sulfuric acid), the elements are adsorbed in the form of hydrolysis products; at a higher acid concentration there is a less appreciable adsorption of neutral complexes $Zr(Hf)A_4$. A comparison of the adsorption of the elements noted on hydrated and silicone-coated silica gel was performed. (tr-auth)

21098 EFFECT OF IONIC FORCE ON THE EFFICIENCY OF DECONTAMINATION OF SOLUTIONS FROM ^{55}Fe. Pavlov-Verevkin, B. S. Radiokhimiya; 12: 682-5(1970). (In Russian).

It was found that with increasing ionic strength of solutions to

be deactivated, containing iron-55, the residual radioactivity after coagulation increases, an effect which must be taken into consideration in the development of methods of deactivation of saline solutions. In the case of the absence of chemical interaction of ions of an extraneous salt with hydroxide ions, the change in the solubility of ferric hydroxide corresponds to the theoretical formulas up to an ionic strength of 0.1 to 0.3. A method was proposed for evaluating the solubility product of hydroxides with radioactive tracers. It consists of a study of the effects of the ionic strength of solutions on the residual radioactivity of water purified by coagulation at pH = 7 and extrapolation of the results to an ionic strength equal to zero. The solubility product of ferric hydroxide was determined by the method described. In this case the value of 3.6×10^{-34} was obtained. (tr-auth)

21099 SORPTION OF STRONTIUM IONS ON NaX, NaA, AND CaA ZEOLITES. Brezhneva, N. E.; Dement'ev, V. D.; Kapshaninov, Yu. I.; Popov, I. B. Radiokhimiya; 12: 545-9(1970). (In Russian).

The process of absorption of strontium ions by CaA, NaA, and NaX zeolites was investigated under dynamic conditions; the exchange capacities of these zeolites with respect to strontium were determined. The process of exchange of strontium for sodium in NaX zeolite was studied under static conditions, and it was established that together with ion exchange there is a process of salt occlusion of strontium. (tr-auth)

21100 SIMPLE AND EFFICIENT PHASE SEPARATOR TECHNIQUE IN LIQUID–LIQUID EXTRACTION WITH RADIONUCLIDES. Havezov, I.; Stoeppler, M. (Kernforschungsanlage, Juelich, Ger.). Radiochem. Radioanal. Lett.; 6: 97-100 (2 Mar 1971).

A very efficient technique for phase separation by centrifuging is described. Examples for the determination of extremely low distribution coefficients, such as $^{90}Sr-^{90}Y$ samples between aqueous and organic solutions, with this technique are given. (auth)

21101 LIQUID–LIQUID EXTRACTION FROM MOLTEN ALKALI NITRATES, USING NEUTRAL ORGANOPHOSPHORUS COMPOUNDS. STUDY OF HEXAMETHYLPHOSPHOROTRIAMIDE. Gonnet, Colette; Porthault, Maurice (Lyon Univ.). Bull. Soc. Chim. Fr.; No. 11, 4157-62(Nov 1970). (In French).

The liquid–liquid distributions of some rare earth elements (Pr, Eu, Yb) between the molten eutectic $LiNO_3-KNO_3$ at 160°C and polyphenyls were studied by using hexamethylphosphorotriamide as extracting agent. The formulas of the complexes extracted and the equilibrium constants of extraction were determined. A separation of rare earths into light and heavy elements is found to be possible. (auth) (France)

21102 EXPERIMENTAL DETERMINATION OF ELUTION REQUIREMENTS IN DISPLACEMENT ION EXCHANGE. Powell, J. E.; Burkholder, H. R.; Gonda, K. (Ames Lab., Iowa). J. Chromatogr.; 54: 259-67(20 Jan 1971).

The progress of separation of any number of lanthanons by displacement ion-exchange elution can be predicted by expressions derived from the basic equilibria involved. The computation process can be reversed so that separation factors are obtained from boundary movement diagrams. (auth)

21103 INFLUENCE OF TEMPERATURE ON THE ION-EXCHANGE PROPERTIES OF STANNIC ARSENATE. SEPARATION OF Pb^{2+}, UO_2^{2+} AND Cr^{3+} FROM NUMEROUS METAL IONS. Qureshi, Mohsin; Rathore, H. S.; Kumar, Rajendra (Aligarh Muslim Univ., India). J. Chromatogr.; 54: 269-76(20 Jan 1971).

The amorphous precipitates (stannic arsenate) obtained by mixing 0.1M aqueous solutions of stannic chloride and sodium arsenate in the volume ratio of 1:1 were dried at different temperatures (40 to 600°C). The ion-exchange properties, the solubility, and the ir studies of the dried samples were investigated. Sorption studies on the sample dried at 40°C were made in detail by raising the temperature (from 20 to 95°C) of the equilibrating solution. Columns were used for the separation of Pb^{2+}, UO_2^{2+}, and Cr^{3+} from numerous metal ions. (auth)

21104 LIQUID–LIQUID EXTRACTION FROM FUSED ALKALI NITRATES BY NEUTRAL ORGANOPHOSPHORUS COMPOUNDS. STUDY OF TRI-n-OCTYLPHOSPHINE OXIDE. Vittori, Olivier; Porthault, Maurice (Lyon Univ.). Bull. Soc. Chim. Fr.; No. 11, 4169-72(Nov 1970). (In French).

Measurements were made of the extraction constants of some rare earths (Pr, Nd, Eu, Gd, Er, Yb) from the lithium nitrate–potassium nitrate eutectic at 160°C into an organic layer containing an extracting reagent (trioctylphosphine oxide). From the extraction constants, the possibilities for the separation of the rare earths Pr–Eu and Pr–Yb are described. (auth) (France)

21105 DEPENDENCE OF THE EXTRACTION CAPACITY OF AMINES ON THEIR IONIZATION POTENTIALS. Makarov, V. M. Radiokhimiya; 12: 584-90(1970). (In Russian).

It was found that the ionization potentials of primary, secondary, and tertiary amines are linear functions of the sum of the ionization potentials of the substituents. It was established that the logarithm of the effective extraction constant is a linear function of the ionization potential of the amine, and the logarithm of the effective coefficient of separation of plutonium (IV) and uranyl nitrates in the case of their extraction by amine salts increases as an inverse linear function of the ionization potential of the amine. Values of the effective extraction constants of uranyl, plutonium (IV), and nitric acid, sums of ionization potentials of the radicals, and ionization potentials of the amines are tabulated. (tr-auth)

21106 EXTRACTION OF NEPTUNIUM(IV) BY AMINES FROM NITRATE SOLUTIONS. Zakharkin, B. S.; Zemlyanukhin, V. I.; Shevchenko, V. B. Radiokhimiya; 12: 577-84(1970). (In Russian).

The distribution of tetravalent neptunium nitrate in extraction by solutions of amines of various types and structures: primary, secondary, aliphatic and aliphatic-aromatic, tertiary aliphatic and aliphatic-aromatic was studied. Variation in the extraction capacity of the amines was explained from the standpoint of the basicity of the amines and the polarity of the salts formed by them. (tr-auth)

21107 COPRECIPITATION OF STRONTIUM, BARIUM, AND RADIUM FROM CALCIUM HYDROXYAPATITE. Popov, D. K.; Mikhailova, A. I.; Dovedov, Yu. A.; Basalaeva, L. N. Radiokhimiya; 12: 573-6(1970). (In Russian).

Calcium hydroxyapatite, a prototype of the bone mineral, was prepared. Experiments on the coprecipitation of microquantities of the alkaline-earth elements with calcium hydroxyapatite indicated that strontium, barium, and radium are capable of being redistributed through hydroxyapatite crystals, and that the process is accompanied by discrimination of the microcomponents relative to calcium ($K = 0.64 \pm 0.03$, $K = 0.68 \pm 0.03$, $K = 0.55 \pm 0.01$). The higher capture of barium and radium by freshly formed precipitates of calcium hydroxyapatite, in comparison with strontium, is explained by surface processes. (auth)

21108 CHLORINATION-VOLATILIZATION PROCESSING OF IRRADIATED URANIUM DIOXIDE. II. SORPTION-DESORPTION OF FISSION PRODUCT CHLORIDES WITH BARIUM CHLORIDE BED. Hirano, Kenmei (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 7: 601-9(Dec 1970).

A study was made on the decontamination of fission products from irradiated UO_2 fuel by means of a sorption-desorption process using a $BaCl_2$ bed. A very high degree of decontamination was obtained. Irradiated UO_2 pellets were pulverized through a repeated oxidation-reduction process, and then chlorinated with CCl_4 vapor at 580°C. The gas containing the vapor of the chlorides formed thereupon was passed through the $BaCl_2$ bed whose temperature varied along its length from 500 to 100°C. The vapor of the chlorides was sorbed on the bed. From this bed, zirconium and niobium chlorides were selectively desorbed by maintaining the bed at between 460 and 480°C in a mixed gas stream of Ar and CCl_4 vapor. The uranium chlorides, remaining on the bed, were then desorbed by maintaining the bed at 500°C in a mixed gas stream of Ar, Cl_2, and CCl_4 vapor. Cesium chloride accompanied the uranium chlorides in this process. Cerium and ruthenium chlorides remained undesorbed on the bed after both desorption processes. The vapor of uranium chlorides desorbed was trapped to recover the U. The γ-decontamination factor of the U recovered after 1, 2, and 3 cycles of the sorption-desorption process was of the order of 10^2, 10^3, and 10^4, respectively. (auth)

21109 STUDIES ON ISOTOPE SEPARATION OF LITHIUM BY ELECTROMIGRATION IN FUSED LITHIUM BROMIDE AND POTASSIUM BROMIDE MIXTURE. III. ENRICHMENT OF ^6Li. Yamamura, Yoshinobu; Suzuki, Shin (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo); 7: 631-4(Dec 1970).

Enrichment of ^6Li by means of electromigration was carried out in a fused LiBr–KBr mixture of a composition of 1.54 (Li/K in chemical equivalent ratio). The electromigration brought about by 847,000 C of charge transported at 520°C produced in the cathode compartment 38.4 mequiv of Li salt with an abundance ratio of the isotopes ($^7Li/^6Li$) of 7.03, as compared with the initial value of 12.58. The distribution of the total amount of salt and of the salt composition in the migration tube agreed well with the results previously obtained on the enrichment of ^7Li. It is suggested that, in view of the similarity in phase diagrams between UCl_4-CaCl_2 and LiBr–KBr systems,

there are logical possibilities of ^{235}U enrichment by analogous procedure. (auth)

21110 PURIFICATION OF A PALLADIUM TRACER AND SEPARATION OF CARRIER-FREE ^{111}Ag BY ANION EXCHANGE IN HYDROBROMIC ACID MEDIUM. Maleszewska, H.; Dybczynski, R. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 6: 7-13(10 Feb 1971).

A convenient method for the separation of carrier-free ^{111}Ag from a neutron-irradiated palladium target was devised, with recovery of a radiochemically pure palladium tracer by anion exchange in hydrobromic acid–bromine medium. The yield of both silver and palladium tracers was practically 100% and high radiochemical purity was achieved. (auth)

21111 SYNTHESIS AND ION-EXCHANGE PROPERTIES OF THORIUM TUNGSTATE: SEPARATION OF La^{3+} FROM Ba^{2+}, Sr^{2+}, Ca^{2+}, and Y^{3+} and of VO^{2+} from Fe^{3+} and Mn^{2+}. Qureshi, Moshin; Nabi, Syed Ashfaq (Aligarh Muslim Univ., India). J. Chem. Soc., A; No. 1, 139-43(1971).

A number of samples of thorium tungstate were synthesized. One of the most stable samples was extensively studied and its formula was postulated as $Th(OH)_2(HWO_4)_2, nH_2O$ on the basis of chemical composition, pH-titrations, and ir spectroscopy. Its utility was demonstrated by determining the distribution coefficients of 26 metal ions. Separations of La^{III} from Ba^{II}, Sr^{II}, Ca^{II}, and Y^{III}, and of V^{IV} from Fe^{III}, Mn^{II}, and Cr^{III}, were achieved quantitatively on columns of this sample. (auth) (UK)

21112 EXTRACTION PROPERTIES OF AN EQUIMOLAR MIXTURE OF D2EHPA–TBP IN KEROSENE. Bykhovtsov, V. L.; Zimina, T. Ya. Radiokhimiya; 12: 686-7(1970). (In Russian).

It was found that an equimolar mixture of bis(2-ethylhexyl) phosphate (D2EHPA)–tributyl phosphate (TBP), previously enriched with uranium from sulfuric acid medium, possesses the ability for supplementary extraction of uranium from nitric acid solutions. Chemical analysis indicated that in the region of limiting saturation, the composition of the extracts obtained corresponds to the formula $[UO_2X_2 \cdot UO_2(NO_3)_3 \cdot 2TBP]$ where X^- is the D2EHPA anion. (J.G.B.)

21113 EXTRACTION OF THORIUM WITH MIXED SOLVENTS FROM NITRIC ACID SOLUTIONS. I. Awwal, M. A. (Atomic Energy Centre, Dacca, Pakistan); Shamsuddin, A. K. Nucleus (Karachi); 7: 190-8(Jul 1970).

The distribution coefficients of thorium were investigated as a function of the concentration of the aqueous nitric acid and mixed solvents. Solvents used were n-methyldidecylamine (MNDDA)–TBP, mesityl oxide (MSo and indexed as 4-methyl-3-penten-2-one)–TBP, ethyl ether (EET)–TBP, and MNDDA–4,4,4-trifluoro-1-(2-thienyl)-1,3-butanedione (TTA). The probable extraction mechanism is discussed. Compositions of the extracted species were found to be: $Th(NO_3)_4 \cdot (TBP)_2$ $(MNDDA)_2$, $Th(NO_3)_4 \cdot MSo \cdot (TBP)_3$, $Th(NO_3)_2(TTA)_2 \cdot (MNDDA)_2$ and $Th(NO_3)_4 \cdot (TBP)_2 \cdot (MNDDA)_2$. (auth)

21114 TREATMENT AND BURIAL OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE IN THE USSR. Spitsyn, V. I. (Inst. of Physical Chemistry, Moscow); Kolychev, B. S.; Sedov, V. M. pp 27-43 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

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The processes developed for purifying radioactive waste include coagulation, ion exchange, and distillation, or in certain cases, the combined use of these techniques. Atomic research centers and nuclear power stations have plants in operation that are satisfactorily treating low- and intermediate-level wastes. The results obtained from the operation of such plants are described, and a brief account given of the electrodialysis process developed for purifying liquid waste and regeneration from acid and alkaline solutions. The results of the work in the solidification of radioactive concentrates by incorporation in bitumens are briefly discussed. To ensure that the radioactive waste from research centers and radioisotopes users in large towns is rendered harmless, special centralized stations were set up that can deal effectively with the burial of the waste. The results of further research into the burial of liquid waste underground are described. The economic characteristics of this method as compared with other well-known methods of waste management are discussed. (auth)

21115 DEVELOPMENTS IN THE TREATMENT AND DISPOSAL OF LOW- AND INTERMEDIATE-LEVEL WASTES AT THE INSTITUTE FOR ATOMIC ENERGY, NORWAY. Neset, K. M. (Institutt for Atomenergi, Kjeller, Norway); Lundby, J. E.; Nielsen, P. O. pp 45-56 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The centralized treatment and disposal of radioactive wastes in Norway is carried out at the National Nuclear Research Institute, which was established in 1948 at Kjeller, near Oslo. At present, approximately 500 people are employed at Kjeller and Halden. Although the quantities of wastes generated are small compared with countries with an extensive nuclear energy program, wastes of varied composition and activity levels are procured from the operation of hot laboratories, pilot-plant processing of radioactive materials, reactor operation (2 and 20 MW), and isotope production. The developments in waste management and treatment from 1948 to 1965 were presented at the IAEA Symposium in Vienna, in December 1965. In the last five-year period the increased activities on projects concerned with prototype fuel testing, post-irradiation examination, reprocessing pilot plants, and isotope production necessitated improvements in waste treatment and disposal. The authorized maximum permissible discharge of low-level liquid waste to the River Nitelva was increased to 2 Ci (weighted)/30 day after the installation of an effluent pipeline, which improves the dilution and dispersal of the activity. Safety assessments show that solidified wastes can be disposed of by shallow land burial within the Institute site, and permission was granted to dispose of one thousand drums containing approximately 250 Ci. The plant for waste processing and storage was modified and improved. Shielding was reinforced, and new equipment installed for remote operation, decontamination, and ion-exchange resin transport and storage. Wastes with contact dose rates of 10 R/hr are now satisfactorily processed, compared with the 1-R/hr level for which the plant was originally designed. Although the waste-treatment plant is relatively simple in design, it has proved to be flexible and reliable in operation. The cost of modifications and new plant equipment amounts to approximately N. kr. 200,000 ($28,000), which corresponds to 25% of the initial plant capital cost. (auth)

21116 SYSTEM FOR THE TREATMENT OF WASTE AT THE NATIONAL CENTER FOR NUCLEAR STUDIES, SANTIAGO, CHILE. Magnasco, M.; Vergara, M. (Comision Chilena de Energia Nuclear, Santiago). pp 195-204 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In Spanish).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

A description is given of the system for treating radioactive waste at the National Center for Nuclear Studies and of the efforts to establish a national policy for the treatment and disposal of radioactive waste. The National Center for Nuclear Studies, now under construction, will have a research reactor of the swimming-pool type, two sub-critical assemblies, a laboratory for the production of radioisotopes, radiochemistry, medical, physics, etc. laboratories, and workshops for maintenance and other work. The creation of a waste disposal system, which does not entail hazards for the population, raises various problems due to the location of the center, which is situated in the outskirts of Santiago. There are no rivers in the vicinity, so that the waste treatment system adopted is one in which the liquid wastes can be discharged into the ground, through absorption systems or the public sewers. The system currently under construction consists of two aging ponds for waste of intermediate activity, two neutralizing chambers and two aging ponds for low-activity waste. The treated liquids will be discharged into the absorption systems or the sewers. Solid residues will be stored after treatment in a vault or in trenches away from the buildings of the center. As regards the establishment of a national policy for the treatment and disposal of waste, studies are being carried out in collaboration with the Chilean National Health Service. (auth)

21117 TREATMENT OF WATER IN STORAGE POOLS FOR UNCONTAINED IRRADIATED FUELS. Bocherel, J. (Electricite de France, Avoine, France); Arod, J. pp 247-60 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The water of storage pools in which irradiated fuel elements were immersed without container is contaminated by the radio-

active products emitted by the elements. This water is maintained throughout the storage period at a pH of 11.5 by the addition of sodium carbonate and soda so as to limit corrosion of the fuel element cladding. The contaminating radioactive elements originate mainly from impurities deposited on the cladding in the reactor, and also from cladding corrosion products. The principal impurities are antimony-124, iron-59, cobalt-60, manganese-54, the zirconium–niobium-95 pair, and sulfur-35. If the cladding is ruptured in the pool, a new contaminating element appears: cesium-137. As a result, the total beta activity of the water may in certain cases exceed 10^{-2} Ci/m^3, which means that the water must be purified. This purification was at first carried out by passing the water over ion-exchange resins—a strong cation exchanger in conjunction with a strong anion exchanger. This method gave good results from the point of view of effluent decontamination but had the disadvantage of producing highly active regeneration liquids. To overcome this difficulty purification was effected by passing the effluents over Cecacite, a calcined sepiolite, which retains the contaminants, particularly cesium, extremely well and once saturated can be treated as solid waste. (auth)

21118 RADIOACTIVE WASTE TREATMENT IN THE TOKAI RESEARCH ESTABLISHMENT OF THE JAPAN ATOMIC ENERGY RESEARCH INSTITUTE. Wadachi, Y.; Machida, Ch.; Sakagishi, S. (Japan Atomic Energy Research Inst., Tokai). pp 313-22 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The types and quantities of radioactive wastes in the Tokai Research Establishment are summarized; also the changes in quality in recent years and their reason. The operation records of the facilities are also given. The Tokai Research Establishment, in cooperation with the Japan Radioisotope Association, collects, transports, treats, and disposes of wastes from other organizations with no facilities for treating liquid and solid wastes. In this connection, the legal aspects, charges of waste collection, treatment, etc, are described. The main problems in waste treatment and disposal are described, including the influence of a final disposal method on the storage of wastes, of treatment of contaminated animal carcasses, etc. (auth)

21119 IMPROVEMENTS IN THE MANAGEMENT OF INTERMEDIATE-LEVEL RADIOACTIVE LIQUID AND SOLID WASTE AT KFA, JUELICH. Rattay, K. H.; Mallek, H. (Kernforschungsanlage Juelich GmbH, Juelich, Ger.). pp 323-9 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

At Juelich solid and liquid wastes are mainly the result of scientific activities and of research reactor operations. At the storage building, which has an area of about 1000 m^2, used since 1965, low- and intermediate-level radioactive solid wastes are temporarily stored. The storage building was equipped with open cells, shielded only by lateral walls. The increasing amount of diffuse radiation has necessitated an improvement of the installation by the construction of an all-round shielded special cell (tunnel cell). The construction of this tunnel cell, the function, and the storage capacity are described in detail. The cell enables the safe storage of 28 200-literdrums, 14 in a row, and freely movable. It was also necessary to construct additional equipment to remove intermediate-level radioactive liquid waste. The treatment of low-level radioactive effluents by an evaporator with vapor compressor and forced circulation has already become a daily routine. The resulting concentrates are formed in a solid state by a vapor-heated double rotary drier. None of these installations have any radiation shielding; therefore it is not possible to treat intermediate-level effluents. This was the main reason for a two-year study to develop a pot drier. The apparatus must treat small amounts of effluents with an initial activity up to 10^{-1} Ci/l. By electric heating the arising vapor is transported by the help of an inert gas (nitrogen), which operates in a continuous cycle. The experiments proved that the technical difficulties especially arise owing to considerable encrustation and contamination of the off-gas system. Only the use of an efficient filter led to better results. This filter is a main part of the pot. Both must be discharged together. This unit will be placed in a 200-liter drum, where it is solidified in concrete. The filter, of wire gauze and steel wool, can only be used for one run. The whole gas and vapor circuit can therefore be kept free of encrustation and heavy contamination. (auth)

21120 DEVELOPMENTS IN THE TREATMENT OF LIQUID EFFLUENTS AT PLUTONIUM PRODUCTION CENTERS. Fernandez, N. (CEA, Bagnols sur Ceze, France); Jourde, P.; Pottier, P. pp 373-82 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Progress in the methods used for the treatment of effluents at plutonium production centers is discussed. This development was dictated by the desire to improve decontamination and concentration factors while at the same time reducing costs. The French centers at Marcoule and La Hague, which differ greatly both in conception and in the possibilities they offer for waste disposal, have contributed several useful solutions to this problem. (a) At Marcoule, acid recovery in the plant itself and specific treatment of the effluents from solvent washing have enabled a large reduction to be made in the volumes and activities of the solutions treated. The most recent methods have become possible through the abandonment of specific ruthenium treatments and the adoption of treatments using manganese dioxide, with recycling, and preformed nickel ferrocyanide. (b) At La Hague, chemical removal of cladding has given rise to a special type of magnesium effluent for which a specific treatment involving precipitation with barium sulfate in conjunction with the use of the previously formed precipitate was devised. This resulted in a new breakdown of effluent categories, so that one can now consider abandoning chemical treatment with calcium carbonate and replacing it by a treatment using carboxyl resin with recycling of the acid eluates towards the magnesium effluent stage. (auth)

21121 INDUSTRIAL METHODS FOR BITUMEN COATING OF LIQUID RADIOACTIVE CONCENTRATES AND STORAGE OF THE BITUMEN BLOCKS. Lefillatre, G. (CEA, Bagnols sur Ceze, France); Andriot, R. pp 383-99 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

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During the past ten years increasing use was made of bitumen as a material for the fixation and solidification of various radioactive wastes, liquid and solid. The advantages of bitumenization of wastes are well known: good chemical stability, little leaching of the radioactivity, simplicity of installations, reduced volume of waste, and moderate cost. Two fundamental criteria governing the choice of bitumen for this purpose, behavior under irradiation and low leaching of radioactivity, are discussed and the characteristics of the bitumens actually selected are given. The bitumen coating procedures tested in France (coating of chemical coprecipitation slurries by the normal effluent procedure and coating of evaporation concentrates by thorough mixing of the cold concentrates, after neutralization and suitable coprecipitation treatment, with the hot bitumen followed by complete dehydration of the coating by means of progressive heating of the soluble and insoluble salts and the bitumen) are described, along with studies undertaken in France with two different technologies (utilization of thin-layer evaporators for α and $\beta-\gamma$ liquid wastes of categories 2 and 3; use of a worm extruder for β and γ liquid wastes of category 4). The utilization of bitumen for the fixation and solidification of radioactive wastes allows a wide choice of final storage methods. The bitumen cases can be stored at ground level or underground in natural caverns, or can be sunk in the sea. However, the choice must always take into account irradiation and thermal emission from the solidified materials as well as the results of leaching tests. Finally bitumenization of intermediate-activity radioactive effluents is a solution which allows long-term storage in conditions of adequate safety and reasonable economy. (auth)

21122 PROCESSING OF SOLID LOW-LEVEL RADIOACTIVE WASTE. Sobolev, I. A.; Khomchik, L. M.; Mukhin, N. A.; Bazhenov, Yu. M.; Sookolov, B. D. pp 401-10 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In Russian).

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The principal methods of reducing the volume of solid radioactive waste are incineration and compacting. The application of these methods in the waste management activities of the Central Radiation Protection Station is considered. It is shown that the

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technological operations involved in waste processing must be preceded by sorting into combustible waste, compressible waste, and waste that can be buried without processing. The basic technological parameters of the incineration of mainly biological waste with a specific activity of up to 5×10^{-5} Ci/kg (paper and textile waste, animal carcasses, and excrement) in a drum-type electric furnace having a capacity (without secondary combustion chamber) of 80 kg/hour are considered. It is shown that, for the incineration of wastes with the activity and composition indicated, it is possible to use a simplified system of gas cleaning, with coke filters and a scrubbing plant in which the scrubbing liquid is liquid waste of low salt content and activity. Unlike "wet" gas-cleaning systems, this system does not lead to the formation of additional liquid radioactive wastes. Volume reduction by a factor of 60 was achieved by the incineration of biological waste. Preliminary estimates indicate that the incineration of biological waste is economically competitive with direct burial in pits lined with ferroconcrete. It is also shown that the compacting of some types of combustible waste by means of a vertical hydraulic press leads to a four- to fivefold reduction in volume. Waste, which cannot be processed in this way (contaminated building materials, metallic objects, pieces of equipment), is placed together with the compacted blocks in ferroconcrete-lined pits and covered with a grout containing liquid radioactive waste and incineration residues. (auth)

21123 PREVENTING ACTIVITY RELEASE AT THE IDAHO CHEMICAL PROCESSING PLANT. Lohse, G. E.; Rhodes, D. W.; Wheeler B. R. (National Reactor Testing Station, Idaho Falls, Idaho). pp 411-18 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

To minimize the release of any radioactivity in liquid effluents, an ion-exchange system was installed at the Idaho Chemical Processing Plant (ICPP) to treat condensate from a process-equipment waste evaporator. In the original installation, cell-floor drain wastes and condensate resulting from the evaporation of intermediate-level wastes were discharged to an injection well after suitable dilution with uncontaminated service water; even with this practice, the radionuclide concentration of the discharged stream never exceeded "controlled" area values. However, to be consistent with a continuing goal to reduce the radioactivity released in all discharged waste streams to the lowest practicable level at ICPP, the original practice was modified so that now essentially all low-level wastes, regardless of concentration, are isolated from nonradioactive wastes. All streams containing any nuclides are routed to an intermediate-level waste evaporator, where decontamination up to factors of 10^6 can be achieved. The condensate from the evaporator is then treated in an ion-exchange system to provide further decontamination factors up to 10^4. Amberlite-200 ion-exchange resin is used for this purpose. The concentration of ^{90}Sr in this final effluent is near drinking-water tolerance before its release to the uncontaminated service-water stream where further dilution results before discharge to the well. In addition, a diversion system is being provided, which will minimize the probability of any accidental release of activity to the environment. In the past, noncontaminated cooling-water streams from heat-transfer surfaces, heat exchangers or condensers, were discharged directly to the injection well. However, in the event of a failure of any heat-transfer surface, some activity could have entered the service-waste stream and thence be released to the environment. Therefore, a system is being provided whereby cooling water can be routed automatically to a spare 300,000-gal waste tank if activity is detected by a radiation monitor located in the line. This diversion system ensures that there will be no accidental loss of radionuclides to the environment and gives ample time for an orderly plant shutdown if a failure cannot be corrected immediately. Any effluent so collected will be processed in the evaporator and ion-exchange equipment before it is discharged to the injection well. (auth)

21124 EXPERIENCES IN THE TREATMENT OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTES IN THE NUCLEAR RESEARCH CENTER, KARLSRUHE. Baehr, W.; Hempelmann, W.; Krause, H.; Nentwich, O. (Nuclear Research Center, Karlsruhe, Ger.). pp 461-84 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

After nearly eight years operation of a pilot plant, where nearly all methods of radioactive effluent treatment, such as chemical precipitation, ion-exchange, and evaporation, were applied, a large plant started operation in 1968 in the Nuclear Research Center, Karlsruhe. As experience with the pilot plant has shown that only a part of the arising effluents can be decontaminated to the required low-activity concentrations by chemical precipitation, the new plant uses nearly exclusively vapor-compression evaporation. Ion exchange proved to be uneconomical owing to the high salt concentrations. The concentrates resulting from the evaporation are fixed in bitumen. Experience in the operation of the pilot plant and industrial plant is reported. Costs of the different methods are compared. The treatment of low- and intermediate-level radioactive solid waste is discussed. For seven years in Karlsruhe a pilot plant for the incineration and baling of solid waste was operated. By continual improvement of special plant components such as filtration of the off-gases by candle filters, a significantly higher security in the operation was obtained. Experience in the operation of this pilot plant resulted in the planned project of a larger plant, which will be started in 1971. (auth)

21125 ELIMINATION OF ORGANIC POLLUTANTS FROM RADIOACTIVE EFFLUENTS. Alexandre, D.; Pottier, P. (CEN, Cadarache, France). pp 649-56 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Detergents are a component of numerous products for the decontamination of various materials as well as of cloth, linen, and rags. They are often associated with complexing agents, such as EDTA. These compounds are afterwards found in the radioactive effluents where they give rise to parasitic phenomena, such as the formation of foam and soluble stable compounds or the development of a biological or chemical need for oxygen. These phenomena disrupt or prevent the decontamination treatments applied to effluents. The user is faced with a dual problem: that of choosing products that meet the requirements for effective decontamination and for disposal of nonradioactive pollutants (this applies especially to the biodegradability of detergents) and that of determining a method of treatment especially adapted to this category of effluents. After a brief description of selection procedures at CEA, a process for treating radioactive laundry effluents is discussed. As a first step, the effluents are passed through an aeration pool with activated sludge. This first stage eliminates the biological, and part of the chemical, requirement for oxygen. The biodegradable fraction of the detergents disappears. The second step consists of treating the effluents with ozone. This reagent eliminates most of the remaining DCO and such components as EDTA, as well as the nonbiodegradable fractions of the detergents. Next comes a process of flocculation, followed by decantation, in which all traces of the sludge are removed and thorough decontamination of the effluent is achieved. Information on the estimated cost components of this treatment is given in the conclusion. (auth)

21126 DEVELOPMENTS IN TREATMENT OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE LIQUID WASTE AT MOL. Van de Voorde, N.; Peeters, K. (BelgoNucleaire, Mol, Belg.). pp 669-88 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The methods used at present to treat low-level active waters at Mol create important volumes of radioactive sludges, which are difficult to filtrate. The process of transforming these concentrates into unleachable solid bulk by incorporating them into bitumen became expensive and cumbersome because of the large quantities and the colloidal state of sludges. Research work was thus carried out to find a method to avoid this cumbersome step. As most volumes of liquid waste to be treated at Mol consist mostly of lightly contaminated drinking water, a method utilizing ion exchangers and sorbents was sought. Conventional organic ion exchangers are generally too expensive to be stored after saturation. Moreover, when bituminized, they give rise to a porous final product. On the other hand, cheaper ion exchangers such as sulfonated coal also cause difficulties when incorporated into bitumen, since large quantities of SO_3 partly destroy bitumen at higher temperatures. By partly sulfonating bitumen itself, an attempt was made to obtain an ion exchanger with sufficient capacity and structure to allow its use in water treatment, but at the same time presenting a sufficient fusibility after saturation to produce a fusible matter when moderately heated. Conditions were also determined whereby a fusible sulfonated bitumen could

be prepared, and this appeared to be practicable although its preparation only resulted in fusible products with limited capacity. The break-through curves of some radioisotopes in contaminated drinking water are to be considered as satisfactory. More promising are the possibilities found in certain synthetic selective mineral sorbents that display a noteworthy selectivity for well-defined ions; however, poor column properties were noted. By simultaneously synthetizing some sorbents, other polyvalent selective sorbents also arise, which show very interesting column properties. (auth)

21127 INCORPORATION OF RADIOACTIVE WASTES CONTAINING SODIUM NITRATE INTO BITUMEN. Volkova, O. I. (Inst. of Physical Chemistry, Moscow); Zakharava, K. P.; Kulichenko, V. V.; Sobolov, I. A.; Khomchik, L. M. pp 725-38 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

An English version of this paper is available in JPRS-51948.

Results of research and experimental work on the process of incorporating wastes containing sodium nitrate into bitumen are described. It was established that a system consisting of sodium nitrate and bitumen shows noticeable oxidation-reduction reactions only at temperatures above the melting point of sodium nitrate and that this reaction may be explosive. At lower temperatures sodium nitrate is bound with bitumen primarily by weak adsorption forces, which may lead to nonuniform distribution of the salt in the bitumen mass. Studies were conducted in the laboratory and on a large-scale unit in order to find the conditions under which these phenomena can be eliminated. Studying the behavior of sodium nitrate, it was possible to determine the process conditions and the specifications of the apparatus required. A description is given of a semi-industrial plant, based on these characteristics, for incorporation of wastes enriched in sodium nitrate into bitumen. The weak adhesion between sodium nitrate and bitumen also affects the behavior of the bitumen products during storage; contact with water destroys the adhesion of the bitumen film to the surface of the mineral particles comparatively easily and leads to absorption of moisture by the product and to leaching of the salt. Observation of bitumen blocks under various conditions has shown that this is a surface process. It was established that the behavior patterns of sodium nitrate and the nitrates of cesium-137 and strontium-90 are not identical. The conditions leading to a reduction of the leaching rate of these salts were determined. The behavior of the bitumen blocks obtained by processing radioactive wastes is being studied during storage in constant and intermittent contact with water, in soil, and on the surface (the work is being conducted under contract No. 645 with the IAEA). The criteria of rational methods for burying bitumen blocks containing sodium nitrate can be evolved from the studies carried out so far. Lastly, the conditions and feasibility of incorporating wastes containing sodium nitrate into bitumen are evaluated. (auth)

21128 IMMOBILIZATION OF RADIOACTIVE WASTES ATTACHED TO NATURAL SORBENTS IN BITUMEN MOULDS. Daiev, Kh.; Delchev, G.; Zhelyazkov, V.; Gradev, G.; Simov, S. (Atomic Energy Commission, Sofia). pp 739-46 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

A method has been developed for the immobilization of radioactive wastes attached to natural sorbents in bitumen molds. The radioactive solutions are passed at pH 5 to 8 through a combined sorbent of vermiculite and zeolite with clinoptilolite in a special bitumen mold. Decontamination coefficients higher than 98% are achieved for cesium-137, thallium-204, silver-110m, strontium-90, and calcium-45. When the sorbent is saturated with radionuclides the mold is plugged with molten bitumen. The resulting bitumen blocks are placed in stainless steel sheet drums, which are kept on platforms out of doors. Vessels are placed below the drums to collect the water (rain and snow), which runs off the bitumen blocks. Each month the radioactivity level of the water is checked and a visual inspection of the blocks carried out. It has been found that blocks made from bitumen used for the insulation of batteries and straight-run distillation bitumen retain their integrity and remain hard for eleven months without there being any indication that longer exposure to atmospheric influences would result in a deterioration. Virtually no radioactivity escapes from the blocks (observations and measurements are continuing). This method is being used for the decontamination of liquid radioactive wastes containing cesium-137, thallium-204, silver-110m, strontium-90, and calcium-45 and with an activity level corresponding to IAEA Category 3 (10^{-3}–10^{-1} mCi/l). (auth)

21129 USE OF BITUMEN EMULSIONS IN TREATMENT OF RADIOACTIVE WASTE (ANIMAL CADAVERS). Ciplea, L. I.; Diculescu, A. (Inst. of Atomic Physics, Bucharest). pp 747-51 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The conditions for using bitumen to preserve contaminated animal cadavers have been studied. The two main problems are the leaching of radioactivity by water and the decomposition of the contaminated cadavers. Experiments made on laboratory animals have shown that the treatment of cadavers with bitumen emulsions inhibits decomposition for a long time. For this procedure to be successful, it is essential to dry the corpses before they are brought into contact with the emulsion. The method is cheap and easy to apply. The waste can be incinerated by ordinary means after the decay of the radionuclides or it can be moved to an incinerator station, which is specially equipped (with filters). The cadavers can be processed, after transport to a central treatment station, by coating them with bitumen or cement. Even in the event of an accident during handling or transport of the waste, the diffusion of radionuclides into the environment is markedly inhibited by the layer of bitumen covering the solid waste. (auth)

21130 THERMODYNAMICS OF THE TBP-EXTRACTION OF RuNO-NITRATO COMPLEXES FROM NITRATE SOLUTIONS. Joon, Klaas (Institutt for Atomenergi, Kjeller, Norway). Z. Phys. Chem. (Leipzig); 243: 249-50(1970).

Experiments show that, from the nitrato RuNO complexes, less than 1% is retained in the TBP phase, provided that the species under consideration has been extracted and conditioned for about 20 min in the TBP phase. The extraction coefficient for each of the nitrate species increases steeply with mixing time up to about 5 sec. Then it stays nearly constant until it starts increasing or decreasing after 3 to 7 min, depending on acid conditions and species under consideration. It was concluded that the extraction proceeds through one or two fast solvation reactions into a dissolvated product. (M.C.G.)

21131 RECOVERY OF BERYLLIUM. (to Fsso Research and Engineering Co.). British Patent 1,222,143. 10 Feb 1971. Filed 25 Jun 1968.

A process for the separation and recovery of beryllium from a mixture containing beryllium halide contaminated with other metallic halides is described. The beryllium is separated by contacting a mixture which contains beryllium halide contaminated with other metallic halides with an aromatic hydrocarbon solvent to form a solution of beryllium halide containing the other metallic halides in suspension. The solution is separated from the suspended metallic halides and beryllium is recovered from the solution. (UK)

21132 DESCRIPTION OF THE SEPARATION PROCESS OF STABLE ISOTOPES OF THE POLYISOTOPIC ELEMENTS BY MEANS OF THE TWO-COMPONENT MODEL. Lyubimov, V. N. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 12, Ser. Khim. Nauk; No. 5, 18-23(Sep 1970). (In Russian).

A two-component model is proposed for description of the separation of stable isotopes of the polyisotopic elements. Some formulas were deduced for the separation coefficient calculation of any real isotope couple from the two-component model. The calculation of isotope separation by ion electromigration in molten salts made with the aid of the proposed model is compared with the published data. (auth)

21133 COEXTRACTION OF ARSENIC WITH MOLYBDENUM. Ivanov, I. M.; Gindin, L. M.; Kheifets, V. L.; Maizlish, R. S.; Kharitonova, T. N. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 12, Ser. Khim. Nauk; No. 5, 153-5(Sep 1970). (In Russian).

The conditions of coextraction of arsenic(V) with molybdenum(V) by quaternary ammonium salts were studied. (auth)

21134 IMPROVEMENTS IN OR RELATING TO ISOTOPIC ENRICHMENT OF URANIUM. Jamrack, William Douglas (to United Kingdom Atomic Energy Authority). British Patent 1,220,441. 27 Jan 1971. Filed 4 Apr 1957.

This invention concerns the isotopic enrichment of uranium comprising the contacting, in a large number of stages, of a solution containing the isotopes of uranium with a solvent. The solvent is substantially immiscible with the solution. The distribution of

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one uranium isotope between the solution and the solvent is different from the distribution of another uranium isotope so that separation takes place. For example, the solution can be aqueous uranyl nitrate and the solvent methyl isobutyl ketone or dibutoxy diethylene glycol. The solution solvent can be contacted in a continucus solvent extraction process or there can be a series of solvent extraction stages in cascade. (UK)

21135 ELECTRODIALYTIC DECONTAMINATION OF APPLE JUICE. Frindik, O. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch.; 144: 179-87(Nov 1970). (In German).

Inactive or radioactive cesium and strontium salts were added to clear apple juice and removed by electrodialysis. Conditions are described for the removal of about 98% of the added quantity of cations, without affecting the quality of the apple juice. (auth)

21136 SEPARATION OF METHYL AND ETHYL IODIDE ON SILVER ZEOLITES. Donner, C.; Tamberg, T. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Atomwirt., Atomtech.; 16: 28-9(Jan 1971). (In German).

Methyl and ethyl iodides were absorbed from air on silver-impregnated synthetic zeolites: Linde molecular sieves. Results showed that excellent absorption rates could only be obtained with sieves that were completely saturated with silver. In comparison to dry air, air containing 30% water vapor showed much higher degrees of absorption. (H.B.G.)

21137 STUDY OF THE FIXATION OF IRON ON TIN DIOXIDE IN NITRIC ACID MEDIUM. Cleyrergue, Ch.; Deschamps, N.; Jaffrezic, H.; (and others) (CEN de Saclay, Gif sur Yvette, France). Radiochem. Radioanal. Lett.; 6: 15-20(10 Feb 1971). (In French).

The fixation of iron on tin dioxide in nitric acid is discussed in regard to the influence of normality and temperature. It was shown that it is possible to separate copper, antimony, molybdenum, and tungsten in samples of iron of about 100 mg by using tin dioxide for the fixation of iron. (E.J.H.)

21138 METHOD AND APPARATUS FOR MASS SEPARATION BY SELECTIVE LIGHT ABSORPTION. Pressman, Jerome (to GCA Corp.). U. S. Patent 3,558,877. 26 Jan 1971. Filed 19 Dec 1966.

A method of separating isotopes, one of which selectively absorbs light of a predetermined wavelength, comprises directing a beam of light across a gaseous beam composed of a mixture of the isotopes to deflect the selectively absorbing species, and collecting the deflected species. Apparatus includes an evacuable chamber, in which there is a molecular beam source of particles including particles selectively absorbing light at a given wavelength and other particles that do not absorb light at that wavelength, means for directing a beam of light across the beam, and collecting means disposed to collect the species separated by the beam. (Offic. Gaz.)

21139 PROCESS FOR SOLIDIFYING RADIOACTIVE WASTES BY ADDITION OF LIME TO PRECIPITATE FLUORIDE. Detilleux, Emile; Hild, Werner Georg; Lazaretto, Gianfranco; Menchero-Lopez, Emilio Manuel; Rometsch, Rudolf. U. S. Patent 3,557,013. 19 Jan 1971. Priority date 7 Apr 1966, Belgium.

A process for solidifying radioactive wastes containing at least one member selected from the group consisting of water-soluble fluoride, water-soluble sulfate, and mixtures of these comprises mixing with agitation at least one liquid radioactive waste with sufficient lime to neutralize the free sulfuric acid and to precipitate the free fluoride, evaporating the water present in the mixture until a hardenable paste is obtained, hardening the paste, and enclosing the resulting block in a watertight covering. (Offic. Gaz.)

21140 SEPARATION OF RHENIUM FROM MOLYBDENUM BY EXTRACTION OF PHOSPHOMOLYBDATE WITH ISOAMYL ACETATE. Yatirajam, V.; Kakkar, L. R. (Kurukshetra Univ., India). Anal. Chim. Acta; 54: 152-5(Mar 1971).

Extraction of Mo(VI) as the phosphomolybdate complex allows separation from rhenium since the perrhenate ion does not form heteropoly anions. A method was developed using isopentyl acetate for the phosphomolybdate extraction from acid solutions. A hydrochloric acid medium was found to afford better extraction than nitric or sulfuric acids. The effects of diverse ions on the procedure are tabulated. (J.G.B.)

21141 FIRST 100 GRAMS OF Pu EXTRACTED IN JAPAN. 6. JAERI'S REPROCESSING TEST PROJECT. Aochi, Tetsuo (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 5, 72-6(May 1970). (In Japanese).

The first hot test of a plutonium-extraction test facility is described. The process involves TBP extraction followed by ion exchange. The objective of the first hot test, carried out after the successive cold tests, was to establish safety of the extraction facility, as well as plutonium extraction, and to observe the behavior of plutonium and fission products. These goals were successfully achieved, and the amount of plutonium recovered was more than expected. The process includes entry of spent fuel from JRR-3 into the facility, removal of the aluminum cladding, and dissolution of the uranium, followed by extraction and separation, and the process of (plutonium) purification and concentration, including evaporation–concentration, extraction, and ion exchange. (Japan)

21142 SYNERGISM IN EXTRACTION CHROMATOGRAPHY. PART II. FACTORS AFFECTING COLUMN PERFORMANCE FOR SEPARATION OF EUROPIUM FROM SAMARIUM AND CURIUM FROM CALIFORNIUM. Aly, H. F.; Raieh, M. (Atomic Energy Establishment, Cairo). Anal. Chim. Acta; 54: 171-6 (Mar 1971).

Synergic effects in extraction chromatography for the separation of europium from samarium have been reported previously. The stationary phase used was a mixture of dibutyl diethylcarbamoylphosphonate and thenoyltrifluoroacetone on Celite, and an acetic acid buffer of pH 3 served as eluent. Studies were continued on the variables affecting the column behavior for the separation of europium from samarium. The different parameters affecting the distribution as well as the separation of the investigated lanthanides were studied in terms of the distribution coefficient, separation factor, and theoretical plate height of the column. From the data obtained, the optimal conditions for the separation of europium from samarium and curium from californium were established. (auth)

21143 SAFETY MEASURES ASSOCIATED WITH THE DEVELOPMENT OF ATOMIC ENERGY. SAFETY IN FUEL REPROCESSING FACILITIES. Aochi, Tetsuo (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 4, 117-20 (Apr 1970). (In Japanese).

Basic considerations in respect to the safety of reprocessing, particularly wet reprocessing are discussed. The radioactivity regulation at a reprocessing facility must be always kept up so that liquid waste may not be introduced into public waters or gaseous waste into air at concentrations greater than those laid down as permissible for water and air by the International Commission on Radiological Protection (ICRP). In connection with dry reprocessing, the permissible concentration of fluorine, temperature control in high temperature reactions, and the handling of gases with radioactive particles are discussed. In any case, the remarkable increase of spent fuel reprocessing will bring about the importance of the safety at reprocessing facilities. (Japan)

21144 FIRST 100 GRAMS OF Pu EXTRACTED IN JAPAN. 5. JAERI'S REPROCESSING TEST PROJECT. Aochi, Tetsuo (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 3, 67-71(Mar 1970). (In Japanese).

The nation's first separation of plutonium in a test facility by extraction with TBP followed by ion exchanges is discussed under the following topics: (1) Final preparation of the test facility. This included removal of the cold-test equipment, and addition of auxiliary equipment. (2) Safety inspection of the test facility. (3) Study on the extraction-test items, and on the hot-test safety. (4) Training of the operating personnel, and the pre-hot-test training practice. All preparation for the final hot test are described. (Japan)

21145 VOLATILIZATION OF FISSION PRODUCTS FROM SOLID URANIUM TETRAFLUORIDE. Weber, M.; Trautmann, N.; Herrmann, G. (Univ., Mainz). Radiochem. Radioanal. Lett.; 6: 73-80(10 Feb 1971).

The volatilization of carrier-free fission products from solid UF_4 was studied up to a temperature of 800°C. Within 30 min, high yields were observed for Mo, Tc, Sb, Te, and I, and moderate yields for Zr. The volatile compounds can be separated by deposition in a glass tube having a temperature gradient. The kinetics of the volatilization were investigated for tellurium showing a volatilization-deposition half-time of 20 sec at 800°C. (auth)

21146 SEPARATION OF RUBIDIUM AND STRONTIUM BY MEANS OF THE KU-1 CATION EXCHANGER FROM SOLUTIONS OF COMPLEX COMPOSITION. Shestakov, G. I. (Geological Inst., Kola, USSR). Zh. Anal. Khim.; 26: 273-7(Feb 1971). (In Russian).

A procedure was developed for the selective separation of sodium, potassium, rubidium, calcium, and strontium from a solution of rock in about 0.1N HCl using the KU-1 sulfocation exchanger in the ammonium form. Alkaline metals were successively eluted with a 0.05N solution of ammonium chloride; alkaline earth metals are eluted with a 1% solution of ethylenediaminetetraacetic acid at pH 6. The additional purification of

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the strontium fraction from ethylenediaminetetraacetic acid and magnesium was carried out on a column with the KU-2 cation exchanger in the ammonium form. Within the sensitivity limits of the flame-photometric method the rubidium fraction does not contain magnesium and calcium. (auth)

21147 ION-EXCHANGE COMPOSITIONS. Rowell, Monte H. U. S. Patent 3,554,919. 12 Jan 1971. Filed 26 Oct 1967.

The preparation and composition of an ion exchange material composed of a boron oxide in major amounts as the primary network former of an alkali metal oxide as the primary network modifier, and of an alkali metal salt as a network extender are described. The alkali metal oxide is either Na_2O, Li_2O, or K_2O; and the alkali metal salt is either NaCl, LiCl, KCl, Na_2SO_4, Li_2SO_4, K_2SO_4, $NaNO_3$, KNO_3, $LiNO_3$, KBr, NaI, or mixtures of these. The ion exchange material is suitable for ion exchange or chromatographic separations of cation solutes in fused salts. (B.L.M.)

21148 PROCESS FOR RECOVERY OF URANIUM VALUES. (to Westinghouse Electric Corp.). British Patent 1,222,807. 17 Feb 1971. Priority date 4 Apr 1968, United States.

Uranium was recovered as ammonium diuranate from an aqueous solution containing uranyl fluoride and hydrogen fluoride by the addition of NH_4OH until the solution had a pH of 6.1 ± 0.2; and when the formation of NH_4F was terminated, sufficient NH_4OH of <3N was added to precipitate the ammonium diuranate. (B.L.M.)

21149 A METHOD OF PROCESSING NUCLEAR FUELS. Avogadro, Alessandro; Wurm, Joseph (to EURATOM). British Patent 1,221,604. 3 Feb 1971. Priority date 25 Oct 1968, Netherlands.

The fuel is oxidized in a molten salt bath consisting primarily of alkali metal nitrates or peroxides at a temperature of 450°C to yield a finely divided product insoluble in the melt and consisting principally of alkali metal uranates and plutonium compounds. The volume of the fuel increases during oxidation to achieve complete detachment from the cladding. Further treatment of the molten mass with gaseous HCl and O_2 dissolves the U in the melt to separate it from undissolved Pu compounds. (B.L.M.)

21150 TREATING RADIOACTIVE WASTE MATERIALS. (to Siemens Aktiengesellschaft). British Patent 1,221,328. 3 Feb 1971. Priority date 19 Feb 1968, Austria.

A method is described for solidifying radioactive waste water containing a boron compound that has a crystalline form. The solution is heated to evaporate the water and increase the concentration of the hot solution to a value such that when the solution is cooled, the remaining water is taken up by the boron compound as water of crystallization, and a solid mass of radioactive material is formed. If the waste solution does not contain a boron compound, a solution of sodium metaborate may be added. (B.L.M.)

21151 METHOD OF PURIFYING AND SEPARATING DERIVATIVES OF FLUORESCEIN SERIES LABELLED WITH RADIOACTIVE MERCURY ISOTOPES. Ratusky, Josef; Kronrad, Leo; Malek, Prokop; Vevrejn, Bohuslav; Kolc, Jiri (to Ceskoslovenska Akademie Ved). British Patent 1,220,499. 27 Jan 1971. Priority date 12 Jul 1967, Czechslovakia.

A method of purifying a derivative of the fluorescein series labeled with a radioactive Hg isotope comprises subjecting a crude mixture of the labeled derivative and at least one by-product to a chromatographic separation on an Al_2O_3 column. By successive washings with water and dilute aqueous alkaline solutions (pH 7 to 14) and due to varying adsorptions of different derivatives and by-products very small quantities (tens to hundreds of mg) of the desired derivative can be separated. (B.L.M.)

21152 PROCESSING OF WATER AND RADIOACTIVE WASTES IN AN ATOMIC POWER PLANT. Mizuuchi, Akira (Japan Organo Co. Ltd., Tokyo). Yosui To Haisui: 12: 593-607(Aug 1970). (In Japanese).

General processing techniques for water and radioactive wastes are described. The water control for a PWR was done using an ion exchange resin system. The condensate water processing in a BWR was carried out by filtration and by using an ion exchange resin apparatus. The processing of the gas wastes of PWR and BWR was carried out by separation with a gas stripper, decay during storage, using a high-quality aerosol filter, and so on. (Japan)

21153 TREATMENT OF THE RADIOACTIVE SLUDGE PRODUCED BY PRECIPITATE FLOTATION METHOD. Koyanaka, Yoshio; Tsutsui, Tenson (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 147-52(1970).

As a part of the experimental studies on the treatment of low-level radioactive waste solutions by the notation method, the effect of collector concentration on volume reduction ratio, the water content of a radioactive sludge, and the dehydration of the sludge by a freeze-thaw treatment were investigated. The volume reduction ratio of flotation increased rapidly with increasing collector concentration, reaching more than 100. The water content of a sludge produced by flotation decreased considerably with increasing collector concentration. The dehydration percentage of the sludge by the freeze-thaw treatment at –25°C was 70 to 90% and the water content of the sludges decreased to 71 to 75%. (auth)

21154 CONTRIBUTION TO THE STUDY OF TECHNETIUM FIXATION ON PLASMATIC PROTEINS. Rebut, C.; Ingrand, J.; Roucayrol, J. C. (Hospital Cochin, Paris). J. Biol. Med. Nucl.: 5: No. 21, 12-16(1970). (In French).

By the use of an automatic apparatus to study the dialysis phenomenon, quantitative and qualitative results on the bond between technetium and proteins were obtained. This method was used for the separation of free technetium from protein-bound technetium in various biological liquids (plasma, synovial liquid) after intravenous injection of pertechnetate. (auth) (France)

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EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 21114–21116, 21127, 21221, 21222, 21226, 21240, 21347, 21349, 21351, 21354, 21355, 21358, 21369, 21373, 21463, 21551, 21619, 21623, and 23202.

21155 (IAEA-R-580) A METHOD AND DEVICE FOR QUICK, POINT MEASUREMENTS OF LEAKAGE RATES THROUGH THE BOTTOM OF RESERVOIRS, CANALS, RIVERS. Zuber, A. (International Atomic Energy Agency, Vienna (Austria)). Dec 1969. 14p. NTIS (U. S. Sales Only).

A new method based on an idea of converting a slow flow through a chosen area of reservoir bottom to a fast flow in a pipe of a small diameter is presented. If the chosen area is tightly covered by a bottomless cylinder with an outlet through a pipe then the product of leakage velocity and the area covered is equal to the product of flow velocity in the pipe and the pipe cross section. Even extremely low leakage velocities render measurable velocities in the pipe if its cross section is very small in comparison with the covered area. This idea can be used for leakage velocity measurements if the measuring device does not disturb natural flow lines. Conditions under which this requirement is satisfied are considered in detail. A measuring device constructed according to these conditions and described in the paper can measure leakage velocities from 5×10^{-7} cm/sec to 3×10^{-3} cm/sec. The flow velocity in the measuring pipe is known from the transit time measurement of an injected pulse of a radioisotope. (auth) (INIS)

21156 (NP-18667) GEOLOGICAL SURVEY RESEARCH, 1970. Chapter D. Geological Survey Professional Paper 700-D. Scientific Notes and Summaries of Investigations in Geology, Hydrology, and Related Fields. (Geological Survey, Washington, D. C.). 317p. GPO $3.75.

Scientific notes and summaries of investigations in geology, hydrology, and related fields performed by members of the Geologic, Water Resources, and Topographic Divisions of the U. S. Geological Survey during fiscal year 1970 are presented. Topics covered under geologic studies include structural geology, stratigraphy, paleontology, paleogeomorphology, geochronology, geochemistry, geophysics, economic geology, mineralogy and petrology, analytical methods, instruments and techniques, and astrogeology. Topics discussed under hydrologic studies include surface water, ground water, geochemistry of water, salt-water intrusion, and waste disposal. An evaluation of analog methods for image registration for topographic studies is included. (L.C.L.)

21157 (PNE-R-37) SANDSTONE CONTINUITY IN THE MESAVERDE FORMATION, RULISON FIELD AREA, N. W. COLORADO. Knutson, C. F.; Maxwell, E. L.; Millheim, K. (Society of Petroleum Engineers of AIME, Dallas, Tex.). 1970. 15p. (CONF-701012-1).

From 45th Annual Meeting of the Society of Petroleum Engineers, Houston, Tex.

Reservoir performance is strongly affected by the rock characteristics. The geometry of the sandstone bodies in the Mesaverde Formation of N. W. Colorado appears to provide insight into the performance characteristics of reservoirs similar to those encountered at Rulison field (the site of the second Plowshare nuclear gas stimulation project). The Cretaceous Mesaverde Formation is a sequence of interbedded sandstones, shales, and coals of flood plain, coastal swamp, and near shore origin. The depositional environments resulted in lenticular sandstone units that have limited areal extent. The Mesaverde outcrops in the DeBeque canyon area, approximately 20 miles west of Rulison field, were studied. Horizontal "controlled" photographs (using a K20 areal camera) of the outcrops were made, enlarged, and overlayed with a 10 foot or 100 foot square grid. Continuous sandstone lenses were traced on the photos, and the length, thickness, orientation of the plane of the outcrop with respect to north, and the X. Y. coordinates of the lens centers were measured and recorded. These data were statistically analyzed using factor analysis, multiple regression analysis and analysis of variance techniques. The analyses indicated a rather low correlation between the length/thickness (L/H) ratio and (a) orientation of outcrop, (b) location in the stratigraphic section, or (c) bed thickness; and L/H ratio averages are within one standard deviation of 20/1. The sand continuity data were used to construct a reservoir model. This was an elliptical sand lens with kh and ϕh decreasing from the center to the edges, with an eccentric well location. Flow and buildup tests plus production data from wells in the Rulison field yielded results consistent with the above mentioned model that was derived from the results of the outcrop study. (auth)

21158 (SC-CR-70-6139) METHOD TO DESCRIBE THE FLOW OF RADIOACTIVE IONS IN GROUND WATER. Final Report, December 1, 1966–June 30, 1968. Grove, David B. (Geological Survey, Denver, Colo. Sandia Corp., Albuquerque, N. Mex.). Dec 1970. Contract AL-66-848. 41p. Dep. NTIS.

An equation based on instantaneous ion exchange and on a linear adsorption isotherm predicts ionic concentrations in the groundwater system as a function of time and position. This equation accounts for radioactive decay, ion exchange, and longitudinal hydraulic dispersion. Critical constants necessary for solution include groundwater velocity, ion exchange distribution coefficient, exchange ratio, and dispersion coefficient. The need for simplicity dictates the use of an equilibrium concept rather than a rate process to describe the ion exchange reaction in the predictive equation. (auth)

21159 (UCRL-50963) HIGH-PRESSURE MECHANICAL PROPERTIES OF ROCKS FROM WAGON WHEEL NO. 1, PINEDALE, WYOMING. Schock, R. N.; Heard, H. C.; Stephens, D. R. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Nov 1970. 18p. Dep. NTIS.

The strength, volume, acoustic velocities, and relationships between shear stress and shear strain were studied as functions of pressure for selected sedimentary rocks in the interval 8942 ft—10,518 ft from Wagon Wheel No. 1. Typical moduli for undeformed sandstone at overburden pressure (~750 bar) are μ = 0.200 Mb, K = 0.210 Mb, and ν = 0.13. With increasing shear stress μ decreases and ν increases, indicating inelastic deformation. The sandstones show almost no purely elastic deformation under shear stress due presumably to the low strength of the fine-grained detrital matrix. At laboratory strain rates ($\sim 10^{-5}$ sec^{-1}) when loading along a path thought to simulate the shock-wave trajectory, the failure surface is not intersected either upon loading or on any extreme unloading path. Higher strain rates may favor intersection, although we have no compelling evidence. (auth)

21160 (USGS-3002-1) GEOHYDROLOGY OF THE AREA NEAR WOSCO EXPLORATORY HOLE NUMBER 1, UINTAH COUNTY, UTAH. Weir, J. E. Jr. (Geological Survey, Denver, Colo.). Dec 1970. Contract AT(49-61)-3002. 27p. Dep. NTIS.

In order to assess the feasibility of fracturing the oil shale in the central part of Uintah Basin by underground explosion of a nuclear device, an exploratory hole (WOSCO exploratory hole Ex. 1) was drilled during July 1969. Geohydrologic data obtained from this hole, drilled to a depth of 985.7 meters (3,234 feet), and other nearby wells are presented along with an interpretation of the data. Jetting tests and a flow test of three water-bearing zones in the Green River Formation of Eocene age indicated very low transmissivities (0.08 to 0.22 cubic meter per day per meter or 6 to 18 gallons per day per foot) and hydraulic heads sufficient to cause flow at the surface. The three zones had a combined flow of 27.3 cubic meters per day or 5 gallons per minute. Water from these zones is briny, ranging in concentration from 37,000 to 72,700 milligrams per liter of dissolved solids. If a nuclear explosive is detonated at a depth of 722.4 meters (2,370 feet), just below the apparent richest kerogen-bearing part of the oil shale penetrated, fracturing reportedly would not extend downward into the upper water-bearing zone of the Green River Formation. Under these conditions, water very likely will not flow into the rubble chimney made by the nuclear explosion. If a few explosion-induced fractures should extend down into the upper water-bearing zone, the resultant inflow to the chimney probably would be small, and dewatering could be accomplished easily by pumping. (auth)

21161 ^{106}Ru MIGRATION IN IRRIGATED SOILS FROM THE BAS-RHONE. Amy, J. P. (CEA, Cadarache, France); Grauby, A.; Jacquin, F. Radioprotection; 5: 185-200(1970). (In French).

Two solutions of nitrosylruthenium complexes, and an uncomplexed solution of ruthenium chloride were used to study ^{106}Ru mobility during earth-column percolation. Ruthenium migration was mainly dependent on its ionic state. Anionic forms were mobile in the soil and a large fraction could be found in the percolate, whereas cationic states were sorbed more quickly. The nature of the soil was also important: ruthenium migrated deeply in sandy soils, whereas it was strongly sorbed by the muddy fractions of soils with a mud-sand texture. Ruthenium mobility in the soils studied was

found to depend more on the solution percolation rates than on particle size distribution, both factors being however closely connected. (auth) (France)

21162 SPECTROMETRIC METHODS OF MEASUREMENT OF THE TERRESTIAL GAMMA BACKGROUND RADIATION AND CONCENTRATION OF RADIONUCLIDES IN THE SOIL. Pensko, Jerzy; Jagielak, Jan; Mamont, Kalina. Nukleonika; 15: 573-83 (1970). (In Polish).

Two different methods of spectrometric measurements are described. They were used to determine the dose rates of gamma radiation emitted by several radioactive isotopes, and the concentrations of those radionuclides in soil. The first method consisted in direct field measurements of the gamma radiation spectra and their dosimetric analysis, the second one in determination of the natural and artificial radionuclide concentrations in the collected soil samples, and in assessing therefrom the respective dose-rates. (auth)

21163 COMPOSITION OF WATER IN CLINCH RIVER, TENNESSEE RIVER, AND WHITEOAK CREEK AS RELATED TO DISPOSAL OF LOW-LEVEL RADIOACTIVE LIQUID WASTES. Pickering, R. J. U. S., Geol. Surv., Prof. Pap.; 433-J: 1-15 (1970).

The fate of radioactive wastes and mechanisms by which radionuclides are dispersed in the Clinch River were investigated, to evaluate its use for disposal of such wastes released to tributary Whiteoak Creek, 20.8 miles upstream from the juncture of Clinch and Tennessee Rivers. Analyzed compositely over 3 years for physical parameters, stable chemical and radiochemical constituents, and suspended sediment, water samples from all three streams were of calcium bicarbonate type related to abundance of limestone and dolomite bedrock of their drainage basins. Constituents varied with seasonal contribution of ground water and dilution of wastes. Suggested associations were: Fe and Mn primarily with suspended solid particles; released ^{137}Cs with solids larger than colloidal particles until dissolved in Tennessee River or associated with colloidal solids; ^{90}Sr perhaps with precipitated calcium carbonate; and ^{106}Ru and ^{60}Co in nitrate solutions released to Whiteoak Creek. (Abstr. N. Amer. Geol.)

21164 SEASONAL VARIATIONS IN THE RADIOACTIVITY OF MATTER SUSPENDED IN RIVERS. Martin, Jean-Marie (Paris Univ.). Compt. Rend., Ser. D; 271: 1934-7(30 Nov 1970). (In French).

The large seasonal variations in the radioactivity of suspended materials transported by rivers is explained in terms of the radioelement distribution in the various granulometric fractions of the sediments. At least 95% of the entire ^{137}Cs fallout is accumulated in the soil. Only a low percentage of ^{137}Cs is transported; relations between the particle size and specific activity were found. In consequence, radioactivity measurements on suspended materials from rivers are not correlated with fallout in the basin. (France)

21165 STUDY OF RECENT DYNAMIC EVOLUTION AROUND THE RHONE MOUTH BY USING RADIOACTIVE WASTES FROM MARCOULE NUCLEAR CENTER. Got, Henri; Pauc, Henri (Centre de Recherches de Sedimentologie Marine, Perpignan, France). Compt. Rend., Ser. D; 271: 1956-9(30 Nov 1970). (In French).

The variations in the artificial radioactivity due to radioactive ^{137}Cs wastes from the Marcoule center were studied by examining core samples taken from the mouth of the Rhone River. This study led to an analysis of the recent hydrodynamic and sedimentologic changes which have occurred in the zone. (auth) (France)

21166 CROSS CHECKING OF FISSION-TRACK AND K–Ar METHODS FOR AGE DATING. I. Shima, Makoto; Okada, Akihiko; Yabuki, Hideo. Ganseki Kobutsu Kosho Gakkaishi; 61: 100-5(1969). (In Japanese).

From Collected Papers of the Institute of Physical and Chemical Research, Tokyo, 871-6(1969).

Recently, the comparison of the different age dating methods was one of the important studies in geology. K–Ar dating of granitic rocks has already been reported. A thin section of the same sample was examined by the fission track method. The measured ages by K–Ar method and fission track method agree well with each other. (auth)

21167 F-RADIOGRAPHIC STUDY OF THE SPATIAL DISTRIBUTION OF URANIUM IN BASALTS, ALKALINO-TRACHITIC IGNIMBRITES, AND SYENITES. Berzina, I. G.; Kravchenko, S. M. (All-Union Scientific Research Inst. of Nuclear Geochemistry and Geophysics, Moscow. Inst. of Minerology, Geochemistry, and Crystallochemistry of Rare Elements, Moscow). Dokl. Akad. Nauk SSSR; 193: 181-3(1 Jul 1970). (In Russian).

Very low concentrations of uranium may be estimated by studying the distribution of tracks of uranium fragments (f-radiography) by means of a detector which records the fragments emitted by the uranium nuclei exposed to a thermal neutron flux. This technique was used to examine the distribution of uranium during natural crystallization processes in basaltic and alkalino-trachitic melts; the effusive rocks give information on magmatic ones which hardened at various stages of crystallization. The rocks studied included quaternary basalts and andesite basalts from the Kurile Islands; Central–Aldanic, alkaline epileucite-orthoclase basalts, alkaline-trachitic ignimbrites and their intrusive analogs, alkaline syenites. The f-radiography established the correlation between various types of uranium concentration and the late or epimagmatic process or the corresponding stages of magmatic crystallization. In vitreous basic masses of effusive rocks the method indicated the fractionation during directed crystallization followed by solidification; in other cases it helped to establish the isomorphic form of uranium entry (melanite, sphene or apatite). (TTT)

21168 ACCUMULATION OF RADIONUCLIDES IN BED SEDIMENTS OF THE COLUMBIA RIVER BETWEEN HANFORD REACTORS AND McNARY DAM. Nelson, Jack L.; Haushild, W. L. Water Resour. Res.; 6: No. 1, 130-7(1970).

Amounts of radionuclides from the Hanford reactors in river bed sediments were estimated from data on radionuclide concentration for the bed sediments between the reactors and McNary Dam; and from data on radionuclide discharge for river stations at Pasco, Wash., and Umatilla, Oreg., 3.2 km below the dam. Accumulations in the Pasco to Umatilla reach estimated by the two methods agree within 8%. In October 1965 approximately 16,000 curies of gamma-emitting radionuclides were resident in the bed sediments between reactors and dam. Concentrations of chromium-51, zinc-65, cobalt-60, manganese-54, and scandium-46 generally are higher near the dam, due to an increase downstream from the reactors in the proportion of fine-grained sediment and proportions of transported zinc, cobalt, manganese, and scandium radionuclides associated with sediment particles. (Abstr. N. Amer. Geol.)

21169 ^{40}Ar-^{39}Ar DATING: THE OPTIMIZATION OF IRRADIATION PARAMETERS. Turner, Grenville (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 10: 227-34(Jan 1971).

Factors involved in the measurement of Ar–K ages by the $^{39}Ar/^{40}Ar$ method are considered in detail. It is shown that the technique is applicable to rocks of any arbitrary age provided a suitable choice is made of the irradiation parameters, namely integrated neutron flux and sample size. The choice of these parameters is determined principally by the approximate age of the sample to be dated and to a lesser extent by the Ca/K ratio. A graphical method for selecting the optimum parameters is presented. (auth)

21170 COMMENT CONCERNING THE APPLICABILITY OF THE OPEN SYSTEM MODEL TO DATING OF FOSSIL BONES FROM SAN JOAQUIN SOIL, CALIFORNIA. Szabo, B. J. (Geological Survey, Denver). Earth Planet. Sci. Lett.; 10: 252(Jan 1971).

Data on the radiometric ages of fossil bones from San Joaquin, California soil obtained by the ^{230}Th method using a "closed system" model are compared with age estimates for the same material using U-series dating by the "open system" model. The results, 83,000 ± 25,000 yr for the "open system" and 103,000 ± 10,000 yr with the "closed system," are concluded to be in good agreement. (L.C.L.)

21171 ^{14}C DATING OF LACUSTRINE SEDIMENTS AND CALIBRATION OF THE ^{14}C TIME SCALE. Geyh, Mebus A. (Niedersaechsisches Landesamt fuer Bodenforschung, Hanover); Merkt, Josef; Mueller, Helmut. Naturwissenschaften; 57: 564-7(Dec 1970). (In German).

The ^{14}C calibration curve of wood is compared with that of annually laminated lacustrine and calcareous muds whose ages were determined by varve counting. The results prove that the discrepancy between ^{14}C and conventional dates, which increases from several hundred to 1400 yrs. over the period from today to 7300 B. P., remains at this high level for at least 2000 years before that. In addition it was found that the ^{14}C dates of the detritic fraction of lacustrine muds are usually reliable, unlike those of the calcareous fraction. (auth)

21172 MINING AND PETROLEUM GEOLOGY. Proceedings of the Ninth Commonwealth Mining and Metallurgical Congress, London, May 3–24, 1969. Volume 2. Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970). 774p. £ 8. (CONF-690561–Vol. 2)).

XUM

Twenty-eight papers were presented in this section of the congress. Individual abstracts were prepared for three of these. (UK)

For abstracts of individual papers see: 21173, 21174, and 21209.

21173 PORTABLE X-RAY SPECTROMETERS FOR RAPID ORE ANALYSIS. Gallagher, M. J. (Inst. of Geological Sciences, London). pp 691-729 of Mining and Petroleum Geology. /Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970).

From 9th Commonwealth Mining and Metallurgical Congress, London, England. See CONF-690561-(Vol.2).

Portable instruments based on the selection of radioisotope-excited fluorescent x-rays with balanced filters have found an important use in the analysis of metalliferous ores since their introduction in 1965. They consist of a probe unit housing the radioisotope source, filters and detector, and a measuring unit in the form of either a rate meter or a simple pulse-height analyzer with a digital readout. A single analysis can be performed in about 1 min. The most suitable radioisotopes currently available are ^{55}Fe (for Ti), ^{238}Pu (for Cr, Mn, Fe, Ni, Cu, Zn and Pb), ^{109}Cd (for Mo and Zr), ^{147}Pm–Al (for Sn and Ba) and ^{153}Gd or ^{57}Co (for W and Pb). Limits of detection on powdered ores are usually a few tenths of a percent, but they can be as low as 0.02% Mo. Results obtained on samples from a wide range of ore deposits are presented, and the effects of varying matrix composition and particle size are illustrated by measurements on mixtures of sized ore minerals. Rapid semi-quantitative analyses can be made on drill-cores, and the portable x-ray spectrometers also offer a simple and reliable means of controlling the performance of wet-gravity separating equipment. (auth) (UK)

21174 APPLICATIONS OF WELL-LOGGING TECHNIQUES TO MINING EXPLORATION BOREHOLES. Threadgold, P. (British Petroleum Co., Ltd., Sunbury-on-Thames, Eng.). pp 731-47 of Mining and Petroleum Geology. /Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970).

From 9th Commonwealth Mining and Metallurgical Congress, London, England. See CONF-690561-(Vol.2).

The development of well-logging in its applications to exploration for hydrocarbons is traced, and it is shown that the interpretation methods used for estimation of porosity in the presence of a multicomponent rock matrix can be used for any multicomponent system. The routine logging tools used for porosity estimates are briefly described, and their responses are discussed. Methods of using these tools to resolve problems of mixed lithology are described and illustrated. The application of other routine logging methods to mining exploration is considered more specifically from a diagnostic viewpoint. Radioactive logging measurements are discussed. The possibility that these could be used to identify the presence of specific elements and, further, to give an estimate of the quantities present, has been realized for some time. The design of logging programs to solve specific problems is described. Various practical problems which have arisen, largely because of the development of well-logging primarily for the petroleum industry, are considered. (auth) (UK)

21175 ONE-DIMENSIONAL INVERSE PROBLEM OF GAMMA LOGGING. Davydov, Yu. B. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 2, 105-9(1970). (In Russian).

A solution is derived for one-dimensional inverse problems of gamma logging for the case where gamma emitters are complexly distributed throughout the thickness of the formation. The distribution of gamma-ray intensity along the borehole axis is given, and the problem is to find the distribution of gamma-emitters; it is assumed that the radioactive element content varies only along the depth coordinate, and that the principle of additivity of gamma radiation is maintained. The solution is achieved by means of an integral equation. (Geophys. Abstr.)

21176 POSSIBILITY OF GAMMA SPECTROSCOPY IN LOGGING IN THE PRESENCE OF RADON IN THE BOREHOLES. Serdyukova, A. S.; Doshchechkin, V. P. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 12, 134-7(1969). (In Russian).

It is shown that to distinguish the part of gamma radiation of ores from the total radiation (ore plus radon), the energy intervals 180 to 230 and 580 to 630 keV, and also 500 to 550 and 580 to 630 keV, should be used in the measurements. In theory other pairs of energy intervals could be used. Comparison of data of spectral gamma logging using the 180 to 230 and 580 to 630 keV intervals with the results of logging on the basis of total gamma radiation in the absence of radon gave satisfactory convergence, which means that spectral gamma logging can be recommended for determining the uranium content in ores. (Geophys. Abstr.)

21177 DETERMINATION OF THE ANGLE OF INTERSECTION OF A WELL WITH AN ORE BODY FROM DATA OF GAMMA MEASUREMENTS. Borzyak, I. P.; Borzyak, I. L. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 7, 92-103(1969). (In Russian).

21178 ESTIMATION OF THE EFFECT OF THE ANGLE OF INTERSECTION OF THE BOREHOLE WITH THE ORE ZONE ON THE RESULTS OF DIFFERENTIAL INTERPRETATION OF GAMMA LOGGING DATA. Zimin, D. F.; Borzyak, I. P. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 1, 106-10(1970). (In Russian).

It is shown that in all cases of differential interpretation of gamma logging data it is not expedient to take into account the effect of the angle at which the borehole encounters the ore body. (Geophys. Abstr.)

21179 STATE AND PROSPECTS OF RADIOLOGICAL INVESTIGATIONS. Afanas'ev, G. D.; Brandt, S. B.; Garris, M. A. Izv. Akad. Nauk SSSR, Ser. Geol.; No. 4, 69-84(1970). (In Russian).

As all published papers on radiometric dating do not give all primary data and critical analyses, attention is called to certain points which absolutely must be taken into account in using geochronometric data. These include the questions of the decay constants of ^{40}K and ^{87}Rb; particulars of geologic information obtained using K–Ar data as a function of the geostructural setting; disturbances of the normal ratio between radioactive and radiogenic isotopes; excess argon in rocks; isochron and concordia plots; and the method of plotting U–Pb concordias. Some prospects of using radiologic investigations to solve complex geologic problems are discussed. (Geophys. Abstr.)

21180 RADIOLOGICAL AGE OF THE PEGMATITE VEINS OF NORTH KARELIA. Stupnikova, N. I.; Zykov, S. I.; Zhirov, K. K. Izv. Akad. Nauk SSSR, Ser. Geol.; No. 4, 85-103(1970). (In Russian).

The North Karelian pegmatites are primary objects for geochronological investigations in the U.S.S.R., particularly by the lead isotope method. All previously published age determinations on accessory rare-earth minerals are summarized and 37 new ones are presented, making a total of 67 minerals. Processing by the Ahrens–Wetherill graphoanalytical method for single veins establishes the stages of superimposed processes, dated at 520 Myr, 290 Myr, and close to recent; the last most probably reflects the effect of hypergene removal or uranium. From the relationship of the ages calculated on the basis of the different isotope ratios, together with removal of lead and uranium, it is established that thorium also has been removed from cyrtolite, allanite, and probably monazite. The actual age of the pegmatites is 1,795 ± 20 Myr. (Geophys. Abstr.)

21181 WAYS OF APPROXIMATELY MODELING GAMMA FIELDS IN MEDIUMS OF DIFFERENT DENSITY AND MINERALOGIC COMPOSITION ON THE BASIS OF THE SIMILARITY PRINCIPLE. Artsybashev, V. A.; Ivanyukovich, G. A. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 9, 118-25(1969). (In Russian).

Methods of approximately modeling gamma-fields in mediums of different density and composition that are applicable to the solution of problems of gamma–gamma logging were examined. It was found that when there is no intermediate zone, methods of approximate modeling of the gamma fields are applicable to 4π and 2π gamma–gamma logging sondes, which violate the requirement of similarity of all sonde elements except length. These are invariant coordinates (with respect to the modeling of the gamma fields) which can be recommended for use to simplify the calculations and generalize the results of experiments. On the right sides of the invariant coordinate there is an effective atomic number of the medium whose value can be calculated by a formula which is given. These ways of approximately modeling gamma-fields can be used to calibrate gamma–gamma logging apparatus in units of density and effective atomic number. (Geophys. Abstr.)

21182 DETERMINATION OF GEOLOGIC AGE BY THE FISSION-TRACK METHOD. Danis, Ana; Onescu, M.; Sandru, P. Stud. Cercet. Geol., Geofiz., Geogr., Ser. Geofiz.; 7: 151-62 (1969). (In Rumanian).

A description of the fission track method of determining ages of rocks and minerals is presented. The method was used on samples of biotite and muscovite from Mina Voineasa in Valea Lotrului. An age of 214 ± 26 Myr was obtained for the biotite sample. (Geophys. Abstr.)

21183 GEOLOGICAL AGE DETERMINATION BY THE METHOD OF FISSION FRAGMENTS TRACKS. Danis, S.; Oncescu, M.; Sandru, P. Stud. Cercet. Geol., Geofiz., Geogr., Ser. Geofiz.; 7: 151-62(1969). (In Rumanian).

A method, based on the fission of heavy elements, allows establishment of the absolute geological age of rocks and the moment of the last metamorphism. Its applicability is restricted to rocks

below the age of 5×10^6 years. In older rocks the fission tracks are effaced. The procedure is based on the property of crystallized minerals to record, by the destruction of the crystal, the fission fragments and recoil nuclei with masses >30. It was first discovered in micas in 1959. The age of the mineral was found to be proportional to the number of fission tracks in it. The method was applied to the micas (biotite and muscovite) of Voineasa (Lotru Mountains–South Carpathians). Since fission fragment tracks are very small, they have been evidenced by chemical etching and irradiation procedures. Younger geological ages could be found by this method as compared with the K–Ar method. The measurement error of the thermal neutron flux could be eliminated by measuring the activity of ^{197}Au. (Rom. Sci. Abstr.)

21184 CERTAIN DATA CONCERNING THE ^{90}Sr CONTENT IN PEAT-SWAMPY SOILS. Ivanov, S. N.; Shagalova, E. D.; Shifrina, S. S. (Belorussian Inst. of Soil Studies and Agrochemistry, Minsk). Dokl. Akad. Nauk BSSR; 14: 849-52(Sep 1970). (In Russian).

The content and behavior of ^{90}Sr in peat-swampy soils was studied. It was concluded that ^{90}Sr penetrates deeper in subsurface peat-swamp soils than in mineral soils, and that the vertical migration increases with an increasing water content of the peat moss. For surface-level peat-swamps most of the ^{90}Sr deposited by atmospheric precipitation remains near the surface due to uptake by the upper-level peat moss. (tr-auth)

21185 ABSOLUTE DETERMINATION OF THE DENSITY OF ROCKS AND ORES IN DIAMOND-DRILL HOLES FROM GAMMA–GAMMA LOGGING DATA. Artsybashev, V. A.; Ivanyukovich, G. A. Razved. Geofiz.; No. 28, 77-86(1968). (In Russian).

Results of the use of gamma-gamma density logging in diamond-drill holes in the Pechenga copper-nickel deposits are discussed. The apparatus used, the operating procedure, and the way of monitoring the stability of the apparatus are described briefly. Results are compared with density determinations made on core samples. Capability of determining absolute density considerably broadens the possibilities of density logging in connection with subdivision of the geologic section, and study of the density of rocks, ores, coals, and other mineral resources. (Geophys. Abstr.)

21186 STUDY OF DENSITY AND POROSITY VARIATIONS OF RIVER SAND BY RADIATION LOGGING. Bahadur, J. (CWPRS, Poona). Irrig. Power; 24: 427-31(1967).

The property of elastic back scattering of gamma rays and neutrons was used for determining density and porosity of loose river sand in-place. The neutron logs for porosity are found to be approximately mirror images of dry density logs. It only shows that an increase in porosity (percentage saturation moisture content in case of saturated sand) results in a corresponding decrease of dry density. The data is presented for a few representative radiation logs to a depth of 8 ft for an area 4 × 10 m. The heterogeneity of subsurface material is illustrated by percentage moisture content contour diagrams. (Indian Sci. Abstr.)

21187 RECOGNIZING AND APPRAISING CHROMITE ORES IN WELL SECTIONS BY MEANS OF A COMBINATION OF NUCLEAR GEOPHYSICAL METHODS. Karanikolo, V. F.; Korotkova, V. A.; Blyumentsev, A. M.; Fel'dman, I. I. Razved. Okhr. Nedr; No. 2, 35-41(1968). (In Russian).

Tests of various nuclear logging methods on chromite deposits show that the method of trapped gamma radiation unambiguously brings out chromite ore and zones with high content of chrome spinels. This method in combination with gamma-gamma density logging and neutron logging using epithermal neutrons offers the possibility of assessing the type of ore and its density. (Geophys. Abstr.)

21188 SELECTION OF REGIONS SUITABLE FOR INDUSTRIAL WASTE DISPOSAL. Tyminskii, V. G.; Spiridonov, A. I. At. Energ. (USSR); 29: 383-4(Nov 1970). (In Russian).

Study of the Tashkent artesian basin revealed that the infiltration front was nonuniform; this was attributed to the action of lithological, structural, and other factors. Although this basin is not suited for industrial waste disposal, it may be used to illustrate the complex hydrodynamic conditions in an aquifer. The age of the calcareous mineral waters of this region ranges from 60 to 80 thousands yr in the north eastern portion of the basin to 4 to 6 million yr in the central portion while the deuterium concentration varied from 0.91 to 1.07 relative units. These data permitted estimation of the mixing of the waters in the basin. The zonal characteristics based on the deuterium content and age of the waters correspond to the distribution coefficients of the migration of uranium and the $^{234}U/^{238}U$ ratio. The region of "young" waters corresponds to high uranium migration coefficients and low deuterium coefficients (<1). This region also coincides with the hydrodynamically determined supply area of the underground water table. The Western region has the lowest migration coefficients. These and other independent indicators permitted determination of the properties of the intermixing water layer, and evaluation of the underground flow rate. On these bases, the areas in which the water does not participate in the mixing process were identified. This region may be considered as an isolated one. (TTT)

21189 RADIOGENIC OSMIUM IN RHENIUM-BEARING ORES. Esenov, Sh. E.; Egizbaeva, K. E.; Kalinin, S. K.; Fayn, E. E. (Inst. of Geological Sciences, Alma-Ata, USSR). Geochem. Int. (Engl. Transl.); 7: 432-7(Jan 1970).

Translated from Geokhimiya, No. 5, 610-15(1970).

The distribution of ^{187}Os, formed in minerals and ores as a decay product of one of the rhenium isotopes, is discussed, and the results of the spectrographic determination of ^{187}Os in rhenium-bearing ores of copper-molybdenum deposits are presented. The $^{187}Os/^{187}Re$ ratio in the ores varied from 1:170 to 1:2200. The possibility of using the rhenium-osmium method for absolute dating of ore deposits is examined. (auth)

21190 DETERMINATION OF CLAY CONTENT IN ROCKS BY MEANS OF THE GAMMA LOGGING METHOD. Wesolowska-Bala, Maria. Przegl. Geol.; 17: 508-11(1969). (In Polish).

On the basis of a large amount of logging data, it is concluded that sandstone-clay and carbonate rocks (not containing admixtures of glauconite, monacite, or other chemical elements distinguished by increased radioactivity) are characterized by an increase in radioactivity with increase in clay content and degree of dispersion. In carbonate rocks from Grzybow, for example, a close correlation exists between clay content and gamma radiation intensity. The method of gamma logging employed in this study is described, and it is suggested that application of this method would permit reduction, on a large scale, of coring and thus reduce drilling costs. (Geophys. Abstr.)

21191 NEW METHOD OF INTERPRETING GAMMA-LOGGING DIAGRAMS USING A DIGITAL COMPUTER. Bobritskii, D. P.; Kuznetsov, M. P.; Leli, A. G. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 3, 140-5(1969). (In Russian).

21192 THEORY OF GEOPHYSICAL GAMMA–GAMMA MEASUREMENTS IN 2π GEOMETRY. PART II. THE RANGE OF MEASUREMENT. Umiastowski, Krzysztof (Inst. of Nuclear Techniques, Krakow). Nukleonika; 15: 215-22(1970).

Results of calculations presented show the dependence of the range of measurement on the energy and collimation of primary photons, and on the discrimination energy of the detector. The results are presented in form of various plots. The possibility of applications of the results for the case of 4π geometry is discussed. The results are compared with experimental data. (auth)

21193 THEORY OF GEOPHYSICAL GAMMA–GAMMA MEASUREMENTS IN 2π GEOMETRY. PART III. UNIVERSAL CALIBRATION CURVE FOR GAMMA–GAMMA LOGGING. Umiastowski, Krzysztof (Inst. of Nuclear Techniques, Krakow). Nukleonika; 15: 259-66(1970).

On the basis of Monte Carlo calculations calibration curves for gamma–gamma density probes were determined. The calculations were carried out with help of similitude principle. The universal calibration curve valid for any energy of primary photons was introduced. The obtained results are compared with experimental data. (auth)

21194 RADIOCARBON VARIATIONS AND ABSOLUTE CHRONOLOGY. Proceedings of the Twelfth Nobel Symposium Held at the Institute of Physics at Uppsala University. Olsson, Ingrid U. (ed.). Nobel Symposium 12. New York; John Wiley and Sons, Inc. (1970). 655p. $45.00.

Thirty-eight papers were presented at the conference. The use of carbon-14 dating in archaeology, pottery analyses, ^{14}C and varve chronology, ^{14}C and dendrochronology, ice-core analyses, exchange rates and radiocarbon in different reservoirs, radiogenic isotopes in the atmosphere and in meteorites, causes of secular $^{14}C/^{12}C$ variations, and dates of $^{14}C/^{12}c$ variations with respect to dendrochronology were discussed. (R.C.K.)

21195 STRATIGRAPHIC GEOCHEMISTRY OF A PENNSYLVANIAN BLACK SHALE (EXCELLO) IN THE MID-CONTINENT AND ILLINOIS BASIN. James, Gerard W. Houston, Tex.; Rice Univ. (1970). 102p. University Microfilms Order No. 70-23,533.

Thesis.

The Excello shale is a widespread Pennsylvanian (Desmoinesian) black shale that covers an area of almost 200,000 square miles in the mid-continent and the Illinois basin. It is the most widespread lithologic unit of the Summum cyclothem. It overlies both marine carbonates and coals, and is overlain by marine carbonates and

XUM

deltaic clastics. The Excello interval averages four feet in thickness and generally consists of a thin basal shell coquina, a thick middle zone of phosphatic dark gray-black clay-shale, and a thin upper zone of lighter-colored, mottled and burrowed clay-shale and claystone. The typically carbonaceous Excello grades laterally into more oxidized greenish-gray facies as it onlaps and crosses structural highs. The nature and distribution of the organic material present in the Excello was characterized by organic-geochemical studies which included the determination of organic-carbon and hydrocarbon contents, and saturate-to-aromatic and hydrocarbon-to-organic-carbon ratios. The Excello in the mid-continent contained greater amounts of extractable hydrocarbons and had higher saturate-to-aromatic ratios and much higher hydrocarbon yields than did the Excello present in the Illinois basin, which contained greater amounts of organic carbon. These differences suggest that the Excello deposited in the Illinois basin incorporated greater amounts of terrestrial plant debris, although the predominant source of organic material in both areas is believed to have been marine phytoplankton and zooplankton. The distribution of uranium and thorium in the Excello was examined by gamma-ray spectrometry. Considerations of the depositional environment suggest that the bulk of the uranium concentrated in the black shale was absorbed or adsorbed by organic complexes enroute to the site of deposition. (Diss. Abstr. Int., B) (TSS)

21196 SIGNIFICANCE OF THORIUM, URANIUM, AND POTASSIUM IN SOME EARLY PRECAMBRIAN GRAYWACKES FROM WYOMING AND MINNESOTA. Rogers, J. W. W.; Condie, K. C.; Mahan, S. Chem. Geol.; 5: 207-13(1970).

Th, U, and K concentrations were measured by gamma-ray spectrometry in graywacke sequences from the Wind River Mountains of Wyoming and the Knife Lake area of Minnesota. The concentrations were compatible with the clay, quartz, and lithic contents of the rocks, but the U contents were low, thus yielding Th : U ratios in the neighborhood of 5 or above. Assuming that all post-depositional elemental abundance variations in the graywackes were caused soley by radioactive decay since the rocks were formed, the initial Th : U ratios would have been in the range of 3 to 4. If the graywackes are random samples of the continental crust at their time of formation, then these data support the data of Fahrig and Eade to the effect that the continental crust 3 Gyr ago had a Th : U ratio significantly higher than that of the whole Earth. (Geophys. Abstr.)

21197 EXPERIMENTAL VALUE OF THE CONVERSION FACTOR FOR THE DETERMINATION OF POTASSIUM CONTENTS BY MEANS OF GAMMA WELL LOGGING. Sen'ko, A. K.; Mishin, G. T. (All-Union Scientific Research Inst. of Prospecting Geophysics, Leningrad). Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; 13: No. 8, 99-101(1970). (In Russian).

The conversion factor for determining the content of potassium by γ-well logging was verified by using a model of horizontal potassium salt layers intersected by vertical drill holes. A mixture of crushed (22 mm mesh) sylvites with potassium chloride, powdered potassium chloride, and radioactive water-insoluble residue (in quantity not exceeding 4%) were used in the experiments. The radioactivity of the residue was combined with a clay substance containing uranium–radium and thorium series and water-insoluble potassium compounds. Measurements with a SI-4 G counter (at background of 2 μr/hr) and scintillation counter with additional 1 mm lead shielding (at background of 1 μr/hr) showed the mean magnitude of conversion factor at z = 18.2 to be k = 2.7 $\mu r \cdot hr^{-1}$ % K and k = 2.5 $\mu r \cdot hr^{-1}$ % K, respectively. (R.V.J.)

21198 PRESENT STAGE AND POTENTIAL DEVELOPMENT OF RADIOMETRIC GEOPHYSICAL METHODS IN OIL-FIELD OPERATIONS. Peteu, G. I. Petrol Gaze; 21: 15-24(Jan 1970). (In Rumanian).

Methods in current use or under development for obtaining information about the physical medium of collector rocks and conditions of oil-field operations are reviewed. These methods yield information on petrophysical properties, lithological formations, the nature of liquids and gases contained in the rocks, etc. The nuclear techniques used to measure the capacity of rocks such as conventional neutron and gamma–gamma logging, gamma-capture, and similar methods are examined, describing also lithological investigations based on natural and induced radioactivity. The fluids collected in the rocks are examined by chlorine logging, neutron time-of-life logging, pulsed-neutron and similar techniques. Radioactive tracers are very useful to determine location of leakage of hydrocarbons. Current development efforts are directed toward the improvement of the precision, standardization and elimination of perturbing factors. (JPRS)

Meteorology

Refer also to abstracts 21622, 21626, 21627, and 21692.

21199 (ARLV–351-16) LOW-LEVEL WIND FLOW OVER EASTERN PANAMA AND NORTHWESTERN COLOMBIA. IOCS Memorandum ESSA-4. Arnett, A. B. Jr.; Steadman, Charles R. Jr. (Environmental Science Services Administration, Silver Spring, Md. Air Resources Labs.). Sep 1970. Contract SF-54-351. 74p. (ERLTM-ARL–26). Dep. NTIS.

For Atlantic-Pacific Interoceanic Canal Study Commission, Washington, D. C.

Analyses are presented of low-level wind data collected along Route 17 in the Darien region of Panama and Route 25 in northwest Colombia, as part of the Interoceanic Canal Studies to determine the feasibility of constructing a sea-level canal across the American Isthmus. Both synoptic (macro-scale) and local (meso-scale) features were examined. Local influences, such as differential heating between land and sea (diurnal), topography, and widespread areas of precipitation are shown to be important factors influencing the low-level wind flow. (auth)

21200 (CEA-R–3977) A STUDY USING RADIOACTIVE TRACERS OF THE EXCHANGE BETWEEN VARIOUS ZONES OF THE ATMOSPHERE OVER THE CONTINENTS AND OCEANS. Nguyen, Ba Cuong (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1971. 175p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

Measurements of ^{137}Cs radioactivity and total β activity from nuclear explosion fallout and of aerosols in suspension in the air, were made over high mountains, the ocean, and the continental plain. From these results, together with measurements of natural radioactivity at altitudes up to 5000 m, a model for the circulation of aerosols in the lower troposphere, over land, and sea was established. Zones of high fallout, probably due to jet-stream undulations, were established. The existence of these zones accounts the ratio of intensities of oceanic fallout to continental fallout varying between 1 and 4. (auth) (France)

21201 (NPS–51-MZ-70101-A) DYNAMICAL MECHANISMS PRODUCING LARGE-SCALE TRANSPORT OF ATMOSPHERIC TRACE SUBSTANCES. Mahlman, J. D. (Naval Postgraduate School, Monterey, Calif.). Oct 1970. Contract AT(49-7)-3206. 187p. Dep. NTIS.

Four papers on the following subjects are presented: the maintenance of the polar front jet stream; a numerical simulation of the advective and diffusive transfer of trace substances in the stratosphere; numerical calculations of stratospheric ozone transport; and a review of various research methods for investigating trace substance transport in the atmosphere. (L.C.L.)

21202 INFLUENCE OF 1968 FRENCH THERMONUCLEAR TESTS ON TRITIUM FALLOUT IN THE SOUTHERN HEMISPHERE. Taylor, C. B. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). Earth Planet. Sci. Lett.; 10: 196-8(Jan 1971).

No significant amounts of short-term tropospheric tritium fallout were detected in the SW Pacific area after 1968 French hydrogen bomb testing, but long-term stratospheric fallout has shown a marginal increase in 1969 to 70 superimposed on the very slow decrease observed since 1965. (auth)

21203 FLUCTUATIONS OF ATMOSPHERIC ^{14}C CONCENTRATIONS DURING THE PAST CENTURY. Baxter, M. S.; Walton, A. (Univ. of Glasgow). Proc. Roy. Soc. (London), Ser. A; 321: 105-27(19 Jan 1971).

Variations in atmospheric carbon-14 concentrations during the past century were studied through the analyses of wines, spirits and plant seeds. The results reveal that short-term fluctuations of carbon-14 concentrations have occurred which are negatively correlated with solar activity. Maximum correlation occurs with carbon-14 concentration minima preceding sunspot maxima by one year. The overall magnitude of the fluctuations, 3% of the natural carbon-14 concentration, appears too large to be attributed to variations in the isotope production rate by solar modulation of the galactic cosmic ray flux. It is proposed that the fluctuations are the result of solar-sensitive mixing of stratospheric and tropospheric air masses through variations of the incident ultraviolet and corpuscular radiation over each solar cycle. Theoretical considerations require that stratospheric carbon-14 levels fluctuate in direct correlation with solar activity. These variations of natural carbon-14 activities in the troposphere represent a significant deviation from the basic assumption of the radiocarbon dating method and may introduce further uncertainty in the dating of "young" materials. In addition, they endorse the universal use of the N.B.S. modern standard in carbon-14 assay. A long-term decrease in tropospheric carbon-14 concentrations was also observed and is attributed to a reduction in the mean production rate of carbon-14 through enhanced solar activity. (auth) (UK)

21204 CALCULATION OF ^{90}Sr CONTENT CHANGES IN ATMOSPHERIC FALLOUT AND ON THE GROUND IN WEST SLOVAKIA UP TO YEAR 2000. Usacev, S.; Dobiasova, Z. (Comenius Univ., Bratislava, Czech.). Jad. Energ.; 16: 420-1 (Dec 1970). (In Czech).

In a theoretical mathematical investigation of fallout activity measurement results, calculations of the mean residence time T_m of ^{90}Sr atoms in the stratosphere and of further ^{90}Sr content changes on the earth surface till 2000 were carried out assuming that there will be no more nuclear tests. The experimental results obtained at Jaslovské Bohunice during the period 1962 to 1966 were used in the calculations. For the purpose of comparison, the T_m value was determined by the graphical method as well. (auth)

21205 AIRBORNE RADIATION FROM THE NUCLEAR POWER INDUSTRY. Knox, J. B. (Univ. of California, Livermore). Nucl. News; 14: No. 2, 27-32(Feb 1971).

It is noted that critics of nuclear power maintain that with expansion of the nuclear industry the average American will be exposed to 170 millirems per year. Data and information are presented to show that such exposure is unlikely. The data are used to support the statement that claims of uniform annual dose commitment to the U. S. population of 170 millirems are without physical foundation. (J.R.D.)

21206 OBSERVATIONS OF WIND PROFILE AT RESEARCH REACTOR INSTITUTE, KYOTO UNIVERSITY. Mizuma, Mitsuo; Iwamoto, Satoshi; Sano, Haruhiko (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 191-7(1970).

Double theodolite pilot balloon studies of wind profiles, carried out at the Kyoto University Research Reactor since the summer of 1969, are discussed and the results of measurements presented. The characteristic features of wind structure around the reactor site were determined. It was noted that there appeared to be no logarithmic wind profile but a constant wind speed up to a few hundred meters was observed at the sites where an open flat area extends for a considerable distance upwind. (R.C.K.)

Mineralogy and Exploration

Refer also to abstracts 20949 and 21172.

21207 (NIM-837) ASSOCIATION OF GOLD AND URANIUM WITH OTHER MINERALS IN DIFFERENT WITWATERSRAND REEFS. von Rahden, H. V. R.; Urli, G. L. P. (National Institute for Metallurgy, Johannesburg (South Africa)). 2 Oct 1969. 43p. Dep. NTIS (U. S. Sales Only).

Factors that could be used for the positioning of the rock-cutter for the maximum extraction of gold and uranium were investigated in samples from the Vaal Reef at Zandpan and Hartebeestfontein and from the Ventersdorp Contact Reef at Venterspost. The relations between gold, uranium, pyrite, the elements Fe, K, Ni, Ti, Zr, and Cr, and the phyllosilicates chlorite, muscovite, and pyrophyllite, were examined statistically to assess whether criteria such as radioactivity and visible sulfide mineralization, or color due to the presence of phyllosilicates, could be used for positioning of the rock-cutter. Quantitative chemical, x-ray diffraction, and x-ray fluorescence analyses were made, and the results were analyzed statistically as a 14-by-14 matrix for the determination of the correlation coefficient of every value with all the other values. Gold and uraninite show a high positive correlation, i.e., they are sympathetically related. They also show a weaker, though very significant, correlation with the other detrital minerals present. Gold and uranium can be simultaneously removed by the rock-cutter, the radioactivity of uraninite being used as a guide to the areas rich in gold and uranium. Visible pyrite mineralization, or coloring of the rock due to the presence of chlorite, muscovite, or pyrophyllite, does not provide a reliable criterion for the positioning of the rock-cutter for the maximum extraction of gold and uranium. The paragenetic sequence of the ore minerals, including gold and uraninite, was established from studies of polished sections. (auth)

21208 CARBONATE-BITUMEN TYPE ALTERATIONS IN URANIUM DEPOSITS WITH OXYGEN ZONALITY OF STRATA. Shchetochkin, V. N. Litol. Polez. Iskop.; No. 4, 92-102(Jul 1970). (In Russian).

Deposits with oxygen stratum zonality and epigenetic ore-bearing rock (bituminization, pyritization, carbonization, etc.) defined by stratified-fissured formations, were studied. The carbon-bituminous-type changes were formed by stages with the participation of large masses of carbon dioxides and other reducing agents. Structural changes are confined to the submerged anticlinal structures and are closely combined with the fractured rock. The carbon dioxide-bituminous-type formation changes were formed by the rising thermal solutions periodically entering through the fractures into the water table levels. Mapping of uranium deposits showed that they usually localized at the pinching out zone of the oxidation strata and spatially were distributed close to the intensive carbon dioxide-bitumen-type formations. Beyond these areas, the oxidation strata zones were either poor ore-bearing or completely barren zones. (R.V.J.)

21209 URANIUM: THE PRESENT AND THE FUTURE. Bowie, S. H. U. (Inst. of Geological Sciences, London). pp 405-20 of Mining and Petroleum Geology. /Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970).

From 9th Commonwealth Mining and Metallurgical Congress, London, England. See CONF-690561-(Vol.2).

With the increase in demand for uranium for nuclear power programs, there is the risk of a shortage soon after 1975 unless immediate steps are taken to rehabilitate certain mines that have been temporarily shut down, to replace plants that are obsolete or obsolescent, and to develop additional reserves in known ore fields. To ensure the longer-term availability of uranium, basic research into the distribution of uranium and the genesis of ore deposits should be intensified and prospecting renewed on a major scale. The success of new prospecting programs will depend to a large extent on the development of novel methods of locating hidden orebodies and of differentiating between radioactivity emitted by various members of the uranium and thorium decay series. More reserves may also be added by improvements in underground mining methods and by the introduction of in situ leaching. As a safeguard against the non-discovery of important new uranium fields, beneficiation research should be renewed with the aim of reducing the cost of treating conventional ores as well as of bringing sub-marginal material into a lower price category. (auth) (UK)

21210 OCCURRENCE OF PROMETHIUM IN NATURE. Meier, H.; Zimmerhackl, E.; Albrecht, W.; (and others) (Staatliches Forschungsinstitut fuer Geochemie, Bamberg, Ger.). Z. Naturforsch.; 25a: 1945-53(Dec 1970). (In German).

After a discussion of former publications on the problem of the existence of promethium in nature, studies on this problem are reported. 200 kg of gadolinite were separated with regard to Pm by using one- and two-stage cation-exchange separations and nitrilotriacetic acid for elution and Cu^{2+} as barrier ion. The experiments yielded a beta activity in the mixture-fractions between Sm and Nd. Because of its chemical behavior and its half-thickness of 4.4 mg/cm^2 that corresponds with a β-maximum energy of 230 keV (^{147}Pm: 223 keV), this beta activity could be identified as ^{147}Pm. For the lanthanide oxides of gadolinite a ^{147}Pm content of $7.3 \times 10^{-17}\%$ could be deduced, which agrees well with the value of $4.5 \times 10^{-17}\%$ found by Erämetsä in 20 tons lanthanide oxides of 6000 tons apatite. The possible origin of the ^{147}Pm found in gadolinite is discussed (fallout, actinium anomaly, spontaneous fission of ^{238}U, and others), and the reaction $^{146}Nd(n,\gamma)^{147}Nd \xrightarrow{11,1d} {}^{147}Pm \xrightarrow{2,6a} {}^{147}Sm$ is supposed to be the cause of the relatively short-lived isotope. The difference between the neutron flux (36 n/cm^2 · min) that was deduced from the saturation activity of ^{147}Pm, and the values of the neutron flux at the Earth's surface or crust (0.001-0.25 n/cm^2 · min) that up to now have been looked upon as probable by other authors, is also mentioned. Moreover, the question of the possible existence of a long-lived isomer of one of the known Pm-isotopes is raised. (auth)

21211 URANIUM ORE DEPOSITS IN PERMOTRIADIC TYROLEAN SEDIMENTS. Schulz, O.; Lukas, W. (Univ., Innsbruck). Tschermaks Mineral. Petrogr. Mitt.; 14: 213-31(1970). (In German).

During an investigation of the mineral deposits in the Northern Graywacke zone of the Tyrol, zones of uranium-thorium enrichment were detected in the Permotriassic sediments unconformably overlying the Paleozoic sequence. In the area south of Fieberbrunn-Hochfilzen pitchblende (parapitchblende) associated with plant remains was found in fine-grained grey sandstones and sericitic sandy shales. The pitchblende frequently occurred together with pyrite, marcasite and chalcopyrite. All these minerals were found in Permoskytic sediments in a form similar to impregnation. They were regarded as being authigenic having formed by syndiagenetic chemical deposition. Nearby country rock contained beds of syndiagenetic magnesite. During the Alpine orogenesis the ore minerals as well as the detrital and authigenic rock components underwent deformation of the lattice structure or cataclastic processes. Post-tectonic processes resulted in mobilization and recrystallization of the rock and ore minerals. The source areas of the uranium are not yet known. The copper ores may be related to Pre-alpidian Paleozoic copper mineralizations.

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Numerous deposits containing such copper mineralizations are found in the Graywacke zone. Goethite, lepidocrocite, digenite, covellite, cuprite, copper, malachite, and zippeite were found as secondary minerals. The distribution of the U-Th enrichment was observed in some beds of the sandstone horizon over a distance of 10 km along strike. At the present time no economic conclusions can be drawn as to the stratigraphic extent and fluctuations of radioactivity; however, this occurrence can be described as the first uranium deposit in Austria where very local U-concentrations of 1% (= 10.000 ppM), in a single case 2% U, were measured. (auth)

21212 URANIUM EXPLORATION SITUATION. Robertson, David S.; Douglas, Richard F. Mining Congr. J.: 55: No. 1, 30-3(1969).

Industry is short today on lifetime fuel for reactors in operation or planned, by about 132,000 tons, and there will probably be a critical shortage by 1982. Geochemically, uranium is a lithiophile element, and its distribution will follow that of zircon, monazite, rutile, and beryl, rather than sulfides. Lithiophile minerals tend to be concentrated by weathering, and it seems unlikely more economic concentrations of large quantities will be found. Reserves in Canada are estimated to be 200,000 tons of U_3O_8, mostly in the Elliot Lake area. Reserves in the western United States are discussed; less than 50 million pounds net were added in 1968. (Abstr. N. Amer. Geol.)

21213 CONTRIBUTION TO THE IDENTIFICATION OF METAMICT MINERALS. Ianovici, V.; Ionescu, J.; Pitulea, G. Rev. Roum. Geol., Geophys. Geogr., Ser. Geol.; 13: 109-15(1969). (In French).

In studying metamictization and molecular regrouping, three types of minerals were examined: fresh minerals; slightly weathered minerals; and strongly weathered minerals. Some chemical analyses, x-ray diffractions, and a special IR spectral study were performed. It was found that the main metallic oxide component was uranium, associated with rare earths, Si, Al, Fe, Ca. The mineral consisted in an inorganic compound incorporated into organic matter (C + volatile substances). The three types of minerals displayed different physical and optical properties. A varied thermal treatment revealed the presence of various oxidation states, and of several crystalline phases. (Rom. Sci. Abstr.)

Oceanography

Refer also to abstracts 21250, 21348, 21351, and 21540.

Seismology

Refer also to abstract 21220.

21214 (AWRE-O-88/70) SURFACE WAVES GENERATED BY ATMOSPHERIC NUCLEAR EXPLOSIONS. Carpenter, E. W.; Marshall, P. D. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov 1970. 42p. Dep. NTIS (U. S. Sales Only). UK 30p.

An approximate theoretical analysis is given for Rayleigh waves generated by atmospheric nuclear explosions. An analysis is made of the seismic recordings of Russian explosions at Noyaya Zemlya and quantitative agreement with the theory is found. Values for the absorption coefficient of the earth are derived and proposals made for a wider use of the stationary phase approximation. (auth)

21215 (BARC-I-64) NUCLEAR EXPLOSION DATA FROM GAURIBIDANUR ARRAY. Arora, S. K.; Krishnan, C. A. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 17p. NTIS (U. S. Sales Only).

Four years' seismic data corresponding to nuclear explosions from October 1965 until the end of 1969, obtained from Gauribidanur seismic array, is presented. Various known test sites are described and detection capability of Gauribidanur array with regard to these sites is briefly discussed. (auth) (INIS)

21216 (CGS-746-9) PROJECT TRINIDAD: DELTA SERIES NUMBERS 1, 2, AND 3, SOPRIS, COLORADO. King, Kenneth W. (National Ocean Survey, Las Vegas, Nev.). 18 Dec 1970. 25p. Dep. NTIS.

Project Trinidad was a series of four row-charges of chemical explosions detonated near Trinidad, Colo. in order to evaluate the economics, efficiency, and seismic effects of using chemical explosives for large-scale excavation in earth and rock. The seismic instrumentation used is described. The results are presented as tabulated measured data on ground motions recorded at various distances from the center of the row charges. (L.C.L.)

21217 (RT/ING-(70)10) GEOLOGICAL INTERPRETATION OF THE SEISMICITY OF THE NORTHERN APENNINES WITH PARTICULAR REFERENCE TO THE BRASIMONE AREA (CASTIGLIONE DEI PEPOLI-BOLOGNA). Selli, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 9 Apr 1970. 47p. (CONF-681224-8). Dep. NTIS (U. S. Sales Only).

From Conference on seismic design specification for a nuclear plant at Brasimone site; Bologna, Italy (2 Dec 1968).

The relationship between earthquakes and the tectonic aspects of the Northern Apennines, with particular reference to the Brasimone area was studied. The intensity, magnitude and acceleration of the maximum earthquake expected at this site are also determined on the basis of all available geological and seismological data. (auth)

21218 (UCRL-50959) METHOD OF PREDICTING SEISMIC DAMAGE TO RESIDENTIAL-TYPE STRUCTURES FROM UNDERGROUND NUCLEAR EXPLOSIONS. Rizer, G. C. (California Univ., Livermore. Lawrence Radiation Lab.). 20 Oct 1970. 14p. Dep. NTIS.

A method of predicting seismic damage from underground nuclear explosions is discussed. The method is a fast and inexpensive way to estimate damage costs and (although less detailed than more formal methods) it provides a dollar estimate of damages accurate enough for planning purposes. The two most important factors affecting the amount of damages are magnitude of ground motion and number of structures near the shot. Ground motion response depends primarily on event yield, distance from source to structures, source geology media, and depth of burial (DOB). With these factors known, a method can be developed for determining the pseudo absolute acceleration (PSAA). The number of structures can generally be estimated from the census data for surrounding towns and cities. Complaints and claims for one- and two-story structures can then be estimated from a graph correlating the PSAA and the percentage of structures expected to be damaged. (auth)

21219 (UCRL-50973) RESPONSE OF A RIGID BODY WITH SIX DEGREES OF FREEDOM ON NONLINEAR SUPPORTS SUBJECTED TO GROUND SHOCK FROM AN UNDERGROUND NUCLEAR DETONATION. Weaver, H. Joseph Jr. (California Univ., Livermore. Lawrence Radiation Lab.). 17 Dec 1970. 17p. Dep. NTIS.

A new shock mounting configuration, called the Universal Guided Column (U. G. C.) System, being used to protect sensitive electronic equipment subjected to ground shock from an underground nuclear detonation, is described. An analytical study of the U. G. C. system is presented. (auth)

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Nuclear Explosions

Refer also to abstracts 21157, 21160, 21202, 21204, 21214, 21215, 21218, 21219, and 22429.

21220 (JAB-99-61) PROJECT RULISON: PRE-SHOT INVESTIGATIONS AND SAFETY HAZARD EVALUATIONS. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Aug 1969. Contract AT(26-1)-99. 46p. (PNE-R-43). Dep. NTIS.

Project Rulison is a natural gas production stimulation experiment planned for a location in Garfield County, Colorado. Design yield is 40 kilotons; maximum credible yield is 60 kilotons. Results of pre-event structural response investigations and evaluations of specific hazards associated with ground motion effects on buildings, hydraulic structures, and earth structures are reported. Total damage repair costs are predicted to be less than $235,000. (auth)

21221 (PNE-G-71) PROJECT GASBUGGY HOLE HISTORIES: GB-E; GB-E-R; GB-1; GB-2R; GB-2RS; GB-D; GB-10-36; GB-2. (Fenix and Scisson, Inc., [Las Vegas, Nev.]). 1968. 65p. Dep. NTIS.

Data on the drilling history, logging, and casing of drill holes GB-1, GB-2, GB-2R, GB-2rs, GB-10-36, GB-D, GB-E, and GB-ER for Project Gasbuggy are presented. (L.C.L.)

21222 (PNE-G-72) GAS PRODUCED FROM GB-ER. ([Fenix and Scisson, Inc., Las Vegas, Nev.]). [nd]. 2p. Dep. NTIS.

Tabulated data are presented on the flow rate and volume of gas withdrawn from Project Gasbuggy drill hole GB-ER during tests conducted from Jan. 1968 to Nov. 1969. (L.C.L.)

21223 (UCRL-50951) HANDCAR NUCLEAR EXPLOSION IN DOLOMITE. Werth, Glenn C. (ed) (California Univ., Livermore, Lawrence Radiation Lab.). 13 Oct 1970. 50p. Dep. NTIS.

The Plowshare Program has continued its study of underground explosion processes with the detonation of a 12 ± 1 kt nuclear explosion in dolomite on November 5, 1964. This experiment, called the Handcar Event, was the first underground explosion in which a permanent gas (carbon dioxide) was generated in large quantities. Heretofore, underground explosions in carbonate rocks had been subject to considerable uncertainty because of the possible effect of the gas pressure on the stemming and safety of such a shot. The Handcar nuclear explosive was emplaced in a 61-cm-diam hole cased with iron and stemmed with pea gravel and three grout plugs. It was fired in a thick dolomite section at a total depth of 402 m. The dolomite extended 167 m above the shot point and was overlain by 235 m of shale, alluvium, and tuff. The rock in the immediate vicinity of the shot point was about 99% dolomite, or $CaMg(CO_3)_2$, plus small amounts of impurities such as quartz, water, iron oxide, and calcite. It had been highly fractured by natural mechanisms and had a fracture porosity of 2% with a correspondingly high permeability. The stemming held and there were no measurable leaks of radioactivity to the surface through the medium, although trace amounts of gas leaked through instrument cables. Logging of three postshot holes and pressurization of the chimney revealed that the explosion produced a cavity with a radius of approximately 21.2 m. This radius is about 14% less than would be expected for an explosion of the same yield in granite. This is consistent with the previously advanced hypothesis that water content of the shot environment is a dominant factor in cavity growth. The cavity partially collapsed and produced a rubble-filled chimney 68 m high (3.2 times the cavity radius) above the shot point. This height is about 27% less than that expected on the basis of results from explosions in fractured granite. The coincidence of the chimney apex with a major change in rock character indicates an influence of natural inhomogeneities on chimney growth. Peak pressure measurements of 100–300 kbar at distances of 9, 10, and 13 m from the shot point are within 20% of preshot estimates. Stress history measurements of about 10 kbar at 45 m agree with calculations to within 25%. Below 5 kbar (beyond 50 m), however, experimentally observed amplitudes were a factor of 2 or 3 below the theoretical predictions. The long-range seismic signal was likewise a factor of 3 or 4 below that expected. The reasons for this are not known, but shock-wave energy losses in fractured materials in the nonlinear zone may be responsible. About $(9 \pm 7) \times 10^8$ liters of CO_2 (at STP) was generated by the heat of the explosion. This decomposition of carbonate rock required 20 ± 15% of the energy of the explosion. In this experiment, the CO_2 generated by decomposition of carbonate rock did not compromise stemming and did not contribute to cavity growth. Radiochemical analyses were made on both solid and gaseous samples. No indication was observed of any gross difference between dolomite and previously studied rocks in the retention of volatile and refractory radionuclides in the rock melt. Gas samples from the chimney region were about one-third air and two-thirds carbon dioxide, with trace quantities of methane, hydrogen, and carbon monoxide. Implications drawn from the specific activity of carbonaceous gases suggest that between 327 and 670 tons of dolomite per kiloton yield participated in ^{14}C exchange. Using ^{85}Kr totals as inferred from device yield measurements, one can calculate the totals of various species mixed with ^{85}Kr. Production of ^{37}Ar was 10^3 Ci/kt, and ^{39}Ar was 120 mCi/kt. The ratio of fission product gases is anomalous, the xenon isotopes being twice the ^{85}Kr in chimney gas. No completely satisfactory explanation is offered. However, the ratio of krypton to xenon is indicative of a rapid chimney depressurization as might be expected in the fractured dolomite matrix. (auth)

21224 STRAIN EFFECTS OF NUCLEAR EXPLOSIONS IN NEVADA. Boucher, Gary; Malone, Stephen D.; Homuth, E. Fred (Univ. of Nevada, Reno). Bull. Seismol. Soc. Amer.; 61: 55-64(Feb 1971).

The University of Nevada's three-component quartz-rod strain meter installation at Round Mountain, Nevada (38°42.1'N, 117°04.6'W) has recorded a number of underground nuclear explosions at the Nevada Test Site, beginning with the megaton-sized JORUM event September 16, 1969. Both that explosion and the larger HANDLEY event on March 26, 1970 produced static strain offsets of a few parts in 10^9 at Round Mountain. These offsets did not decay within the first few hours after the explosions. In both cases, the strain offsets were in the sense of ground extension radial to the shot point, which is inconsistent with the assumption of a pure compressive source of strain. The strain-change ellipse for the HANDLEY event was found to have a major strain axis of 11×10^{-9} extensional, oriented N 34°W, and a minor axis of 7.4×10^{-9} compressional. A single-component strain meter at Mina, Nevada, (38°26.3'N, 118°9.3'W) was operated for the HANDLEY event, and recorded a strain offset of 2.6×10^{-9} in the direction N 74°E. Strain offsets at the time of the largest collapse events following HANDLEY were observed at Round Mountain. These offsets had the same sense on each component as those following the explosion itself. This is interpreted as support for the hypothesis that the strain changes are tectonic in origin, and the explosion initiates the strain release. Small offsets were observed for three smaller explosions out of a total of 13 studied. The relationship between body-wave magnitude m_b and maximum dynamic strains at Round Mountain may be described empirically by the equation $\text{Log } S = -13.4 + 1.10\, m_b$. Because of its high sensitivity and stability, the Round Mountain strain meter is capable of obtaining useful measurements of dynamic and static strain effects of intermediate- to large-sized explosions, at distances ranging from 160 to 200 km. (auth)

21225 AMPLIFICATION OF SEISMIC BODY WAVES BY LOW-VELOCITY SURFACE LAYERS. Murphy, J. R.; Davis, A. H.; Weaver, N. L. (Environmental Research Corp., Las Vegas, Nev.). Contract AT(29-2)-1163. Bull. Seismol. Soc. Amer.; 61: 109-45(Feb 1971).

Frequency-dependent amplification of seismic waves by near-surface low-velocity layers is a well-known phenomenon. This phenomenon was examined from both the analytic and experimental viewpoints for body waves (P,SV,SH). Ground-motion data, recorded in conjunction with the underground nuclear testing program at the Nevada Test Site, are used to provide experimental validation of the analytic models. Experimental amplification factors are derived from these data for a variety of recording-site near-surface geological configurations (alluvium, mine tailings, fill) and a wide dynamic range of ground-motion intensity (10^{-5} to 10^{0}g). The variability in the mean amplification observed at a site for repeated measurements is described statistically. This analysis shows that, although the amplification at a given site varies on the average by a factor of about 1.4 across the frequency band of interest, from detonation to detonation, the frequency and magnitude of the dominant amplification are fairly consistent. The quality of the comparisons of the observed and calculated amplification indicates that the available linear analytic models are capable of describing the major features of the frequency-dependent amplification observed for this wide range of ground-motion intensity and recording-site geology. (auth)

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21226 INFLUENCE OF WATER IN ROCKS ON EFFECTS OF UNDERGROUND NUCLEAR EXPLOSIONS. Butkovich, T. R. (Univ. of California, Livermore). J. Geophys. Res.; 76: 1993-2011(10 Mar 1971).

The influence of water in silicate rocks in which underground nuclear explosions were detonated was observed. Explosions in high-water-content rock cause larger cavities to be formed, and in cratering shots higher peak spall velocities are measured when the detonation occurs in a high-water-content rock. A water-boost model is proposed whereby the region around an underground nuclear explosion is treated as a two-component system on release from its peak shock pressure. The region referred to is that in which the rock is melted or just heated and the water contained within is totally or partially vaporized. The release path for the system is calculated from the release paths of the two components weighted by the fractional percentage of each component. The model was tested by making one-dimensional calculations with a computer code designed to calculate the effects of underground explosions on the environment. The calculational results were compared with measurements in rocks with water contents ranging from a fraction of a percent to over 25% by weight. Excellent agreement was obtained for peak stress in the kilobar region, the cavity radius, and the free surface velocity for a cratering event. For close-in measurements of shock-wave time of arrival and peak pressure in the 100-kb region, a phase change in the rock component, similar to that observed to occur in rock shocked to high pressures in excess of 100 kb, was introduced to give good agreement between measurement and calculation in this region. The importance of the rock component phase change further out, in the kilobar region, does not seem to be significant. (auth)

21227 SOME EXPERIMENTAL RESULTS FROM UNDERGROUND NUCLEAR EXPLOSIONS. Rodionov, V. N.; Tsvetkov, V. M. At. Energ. (USSR); 30: 31-6(Jan 1971). (In Russian).

The experimental results of nuclear explosions on the mechanical properties of salt are discussed. According to the analysis of the parameters of compressional waves, the magnitude of plastic strains and medium strength are estimated. By the comparison of the radiating wave parameters and the contained cavity volumes it is shown that in the plastic strain region the salt density is less than the initial one. It has been proposed that at deep explosions the final cavity volume is appreciably less than the maximum. (auth)

Facilities and Equipment

Refer also to abstracts 21000, 21078, 21129, 21144, 21219, 21252, 21253, 21268, 21269, 21286, 21369, 21371, 21408, 21444, 21481, 21905, 22025, 22210, 22211, and 22465.

21228 (ANL-7760(Pt.2), pp 45-6) CONSTRUCTION OF NEW SHIELDED ROOMS. Rundo, John (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969-June 1970.

Three similar welded steel rooms being constructed underground as shielded facilities for the measurement of body radioactivity are briefly described. (L.C.L.)

21229 (BARC-I-46) CALIBRATION AND CHARACTERISATION OF THE COBALT-60 PRODUCT BOX IRRADIATOR AT FIPLY. Krishnamurthy, K.; Aggarwal, K. S.; Patil, N. D.; Dutta, S. S. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 32p. NTIS (U. S. Sales Only).

Results of investigations carried out to calibrate and characterize the cobalt-60 product box irradiator at FIPLY (Food Irradiation and Processing Laboratory), B.A.R.C., Trombay, are described. The irradiator was calibrated using chemical and perspex dosimeters with product boxes filled with target materials of varying densities. The dosimetry systems used in these calibrations were the Fricke dosimeter, the Perspex H. X. dosimeter and the ceric sulfate dosimeter. Dose distribution in targets with different materials of varying bulk densities thickness were studied. The calibration procedures covered the determination of dose distribution pattern in the front, middle and back planes of targets in static systems and uniformity ratios for various target materials in cyclic motion. Various characteristics of the irradiator such as throughput, maximum and minimum dose rates, efficiencies, and dwell time for various target densities were also evaluated. Computational methods were employed to arrive at a dose distribution pattern from a uniform source of the same strength and size as that of FIPLY. A comparative study of the results obtained from computational techniques and experimental observations was made to estimate the effective Curies available for processing applications. (INIS)

21230 (BARC/INF-3) NUCLEAR FUEL COMPLEX, HYDERABAD. (Department of Atomic Energy, Bombay (India)). Jul 1970. 5p. NTIS (U. S. Sales Only).

The Nuclear Fuel Complex which is being built at Hyderabad will be capable of entire range of operations from raw mineral concentrates to finished fuel element assemblies and other reactor components for power reactors of different designs in India. The Complex is made up of the following units: 1) Uranium oxide plant to process uranium ore into reactor-grade uranium oxide powder, 2) integrated zirconium plant to process zircon into zircaloy, 3) ceramic fuel fabrication plant where sintered pellets of UO_2 will be sealed into Zircaloy, tubes and assembled into fuel element bundles, 4) enriched uranium oxide plant where enriched UF_6 will be processed into ceramic grade UO_2 powder, 5) enriched uranium fuel fabrication plant where the enriched UO_2 powder will be fabricated into finished Zircaloy-clad fuel elements for the Tarapur Power Station, 6) special materials plant for the preparation of ultrahigh purity (electronic grade) materials like antimony, indium and selenium required for the electronics industry, and 7) zirconium powder plant to convert zirconium sponge metal to micron size zirconium powder for use in industry. A quality control laboratory will also be set up at the complex to ensure the quality of finished products. The complex is scheduled to attain full production by mid-1972. In order to utilize fully the capacity available in the zircaloy fabrication plant, it has been proposed to undertake in this plant, the production of seamless, steel tubes useful to other industries. Stainless, heat-resistant, high-alloy and low-alloy steels will be processed. (INIS)

21231 (CONF-700816-(Vol.2), pp 459-66) ENERGY SOURCES OF TOMORROW. Johnson, W. E. (Atomic Energy Commission, Washington, D. C.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The energy required in the USA in the future to keep the environment habitable for an expanding population and the relation between our environment and energy are discussed. It is concluded that 6 times the present electric energy capacity will be needed by the year 2000 to clean the environment and to maintain a reasonable standard of living for the additional population. Methods must be found for producing, distributing, and both cleanly and economically using fossil fuels. The more efficient breeder reactors must be developed for the economic use of nuclear fuels in commercial power plants. Finally, a nationally coordinated system for planning, developing, constructing, financing, and operating power plants is needed to achieve both the future electric energy needs and the environmental compatibility requirements. (L.C.L.)

21232 (IEA-212) DESCRIPTION OF "SANDSTONE OVEN" FOR IRRADIATION OF SAMPLES IN A REACTOR AND MEASUREMENT OF THEIR ELECTRICAL RESISTANCE. Brosson, Philippe; Lucki, George; Rechenberg, Hercilio; Sordi, Laura; Tiberghien, Raphael (Instituto de Energia Atomica, Sao Paulo (Brazil)). May 1970. 20p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

An apparatus for measuring electric resistivity in short wire samples is described. Using this device, it is possible to expose the samples to neutron irradiation (swimming pool reactor) and to follow the evolution of their resistivity. The oven in which the sample is placed is described. Thermal treatment is selectable between 100 and 600°C, allowing a variety of studies in solid state physics to be conducted. (auth)

21233 (NYO-3864-2) DEVELOPMENT OF A RADIOACTIVE PEBBLE BED CHEMICAL REACTOR SYSTEM. Phase III Report, July 1, 1968-June 30, 1970. Yang, J. Y.; Cullinan, H. T. Jr.; Thomas, C. C. Jr.; Ives, B. F. (Western New York Nuclear Research Center, Inc., Buffalo). 15 Sep 1970. Contract AT(30-1)-3864. 62p. Dep. NTIS.

A bench scale radioactive pebble bed chemical reactor was designed and constructed for the side-chain chlorination of toluene. The reactor, consisting of a two-inch diameter jacketed column, was designed for constant temperature operation at 80°C. The construction of the laboratory test reactor required extensive modifications of commercially available small equipment. However, the components suitable for an industrial scale reactor for the toluene chlorination process are commercially available. The radiation shielding and safety requirements for an industrial fluidization reactor using low specific activity ^{90}Sr microspheres as radiation sources are not expected to be excessive. Toluene chlorination experiments were carried out using 5 Ci of ^{90}Sr-^{90}Y in

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160 g strontium silicate microspheres in the two-inch bench scale reactor. The chlorination rates were somewhat lower than those observed previously with initiation by 1-MeV electrons from a Van de Graaff accelerator. This lower rate is attributed at least in part to the inability to maintain optimum fluidization conditions. The presence of microsphere particles did not appear to inhibit the chlorination reaction. The energy yield for the chlorination was sufficiently high to satisfy the economical feasibility criteria for the development of a radioactive pebble bed reactor. Strontium silicate microspheres received from the Oak Ridge National Laboratory were found unsatisfactory as immersible sources. First, these particles had large variations in size and density distributions, and they required extensive classification efforts to yield fractions suitable for homogeneous fluidization at high bed porosities. Second, there were voidage imperfections in large portions of the beads—leading to undesirable attrition under the needed fluidization conditions. Third, strontium silicate microspheres appeared to be unstable under acid conditions. Procedures for the characterization and classification of both inactive and radioactive microspheres were developed. Fluidization studies were carried out to investigate the extent of liquid density and viscosity effects as well as the effect of particle size and density distributions. For particles with a finite density range of 3.30 to 3.65 g/cm^3 and a size range of 177 to 250 microns, it is possible to achieve homogeneous bed expansion up to a linear expansion factor of about 10. With uniform density beads of one standard sieve size, the fluidization reactor can be operated with linear bed expansions up to 20 or 30. The results of the study indicate that the concept of a radioactive pebble bed reactor is feasible for certain types of chemical processes. However, such a reactor cannot be developed economically until a suitable immersible source is available. Due to difficulties encountered with the available source particles, our original goal to derive a model for extrapolation to an industrial scale toluene chlorination process was not realized. (auth)

21234 (ORNL-tr-2414) PRELIMINARY STUDY ON CHOPPING COMPLETE FUEL ELEMENTS OF THE SNR-Na2 AT WAK. Roth, B. F.; Becker, H. (Kernforschungszentrum, Karlsurhe (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report NP-18451. 41p. Dep. NTIS.

This paper was abstracted from the original language and appeared in NSA as 24: 48208.

21235 BIOLOGICAL IRRADIATION PLANTS USING ^{137}Cs. Tech. Mod.; 62: 441-42(Oct 1970). (In French).

Methods of preparing ^{137}Cs are briefly discussed and the advantages of this type of source described. Four models of laboratory irradiators recently put into service (equipment destined for the irradiation of animals, radiopasteurization, radioecology and the irradiation of liquids) are described. (France)

21236 BASIC PROGRAM OF THE DEVELOPMENT AND UTILIZATION OF ATOMIC ENERGY FOR FISCAL 1970. Kagaku Gijutsucho Geppo; No. 166, 1-4(Jun 1970). (In Japanese).

A program for the development and utilization of atomic energy for fiscal year 1970 is described. In the fiscal year (from April 1970 to March 1971), activities include the start of construction on a prototype advanced thermal reactor, the furthering of research and development on uranium enrichment and nuclear fusion, the start of construction on a nuclear fuel reprocessing plant, the start of equipment on the first nuclear-powered ship, and commissioning of a number of atomic power stations. The program of the development and utilization of atomic energy for fiscal 1970 is described, including the basic policy, research and development, utilization, safety measures, fuel supplies, cooperation, and budgets and personnel. (Japan)

21237 CLINICAL EVALUATION OF A NEW PORTABLE UNIT RADIOGRAPHIC TECHNIQUE. Wing, Kenneth R.; Soeremark, Rune; Hulting, Bengt (Swedish Research Council's Lab., Studsvik, Sweden. Nykoeping Hospital, Sweden). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 111: 408-15(Feb 1971).

Two new portable radiographic units employing an iodine-125 source and Polaroid Land films with an intensifying or fluoroscopic screen were assembled and evaluated clinically. The units are small, light in weight, simple to operate and completely independent of both electrical power and darkroom facilities. The energy of the radiation emitted by the source, predominantly 22 to 35 keV, is best suited to the examination of the hand, wrist, forearm, foot, jaws (unilateral) and foreign bodies or calcifications in soft tissue masses. Of the film-screen combinations tested, Polaroid Types 57 or 107 Land films with a Du Pont Lightning Special intensifying screen were chosen as the best compromise of the conflicting demands for good image quality and reasonable exposure times with a source of limited output. The skin dose incurred by the subject with the portable units is less than 4 per cent of that for making comparable roentgenograms with a conventional roentgen ray tube and Kodak Kodirex film. While many common types of fractures can be detected using the portable radiographic unit technique, the limit of the diagnostic usefulness of these radiographs lies short of the demonstration of fractures in which little or no displacement of the fragments has occurred. Blurring due to subject movement is also a problem as the exposure times are relatively long and must be increased with time to compensate for the decay of the radionuclide. Despite these limitations, these portable units should be quite useful in situations in which radiographic diagnosis would otherwise be impossible and, in addition, in the fields of forensic medicine and materials inspection, where exposure times of several minutes or more can easily be tolerated. (auth)

21238 AUTOMATIC ANALYTICAL LABORATORY FOR MASS-SPECTROMETRIC ISOTOPIC-DILUTION ANALYSIS OF URANIUM AND PLUTONIUM IN FUEL SOLUTIONS. Wilhelmi, Marlies; Beyrich, W.; Gerin, F.; Romkowski, M.; Tasman, H. A. (Europaeisches Institut fuer Transurane, Karlsruhe, Ger. Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). pp 165-76 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

An automatic system was planned for mass-spectrometric isotopic-dilution analysis of uranium and plutonium in fuel solutions. The individual basic processes, i.e., sampling, spiking, and chemical processing of the samples, mass-spectrometric measurement and calculation of the analytical data, are automated independently. Experience obtained over four years of manual processing and measurement of several hundreds of samples caused the conversion to automation. The different process steps required for sampling, spiking, and chemical processing of the samples are implemented by components which are combined by a unit-construction system. For the mass-spectrometric measurements commercial equipment has been automated. The sample throughput of this equipment is to be increased to 48 measurements per 24 hours by means of a high-vacuum lock system for preheating the samples. Further commercial equipment is used to calculate the results of the analyses whose program is being developed. The concept and designing of the facility and the present state of development are reported. (auth)

21239 APPLIED MECHANICS. Proceedings of the Twelfth International Congress of Applied Mechanics, Stanford, California, August 26-31, 1968. Hetenyi, M.; Vincenti, W. G. (eds.). Berlin; Springer-Verlag (1969). 444p. $27.00. (CONF-680835).

The texts of four lectures and 26 contributed papers that were given extended coverage at the Congress are presented. The book also contains a resume of the Congress, a listing by title and author of the 255 shorter contributed papers, and a list of participants. The papers are on a wide range of subjects in solid and fluid mechanics. (J.R.D.)

21240 MINERAL PROCESSING AND EXTRACTIVE METALLURGY. Proceedings of the Ninth Commonwealth Mining and Metallurgical Congress, London, May 3-24, 1969. Volume 3. Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970). 938p. £ 12. (CONF-690561-(Vol. 3)).

Thirty-seven papers were presented in this section of the congress of which two were considered in scope for NSA. Individual abstracts were prepared for these two papers. (UK)

For abstracts of individual papers see: 21241 and 21463.

21241 APPLICATION OF HETEROGENEITY EFFECTS ENCOUNTERED IN THE ABSORPTION AND EMISSION OF X-RAYS TO ON-STREAM SENSING OF VARIABLES SUCH AS PARTICLE SIZE. Carr-Brion, K. G. (Warren Spring Lab., Stevenage, Eng.). pp 509-21 of Mineral Processing and Extractive Metallurgy. /Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970).

From 9th Commonwealth Mining and Metallurgical Congress, London, England. See CONF-690561-(Vol.3).

Sensors using x-ray attenuation and x-ray fluorescence were developed to indicate variations in particle size in process streams; with radioisotope sources they are rugged, compact and suited to an industrial environment. Their theoretical background is examined briefly, and their applications and future potential are discussed. (auth) (UK)

21242 RADIATION DAMAGE STUDIES USING THE LOW TEMPERATURE IRRADIATION FACILITY. I. INSTRUMENTATION. Kitajima, Kazunori; Koiwa, Masahiro; Itoh, Noriaki; (and others) (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 198-201(1970).

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The low-temperature irradiation facility of the Kyoto University Research Reactor is described. A thermoelectric force-free potentiometer was used to measure the electric resistance of high-purity Al, Cu, Fe, Pt, Al–Mg alloys, and Al–Cu alloys inside the loop. Equipment for measuring internal friction of specimens inside the loop is described. Equipment and methods for out-of-loop measurements following irradiation are also described. (R.C.K.)

Heat Transfer and Fluid Flow

Refer also to abstracts 21275, 22007, 22008, 22088–22091, 22175–22178, 22203, 23272, 23273, and 23280.

21243 (CSIR-SR-CHEM-133) DETERMINATION OF FLUID VELOCITY AND DIRECTION IN OPEN TANKS WITH A PROBE USING RADIOACTIVE PULSES. Scott, K. J.; Paulsen, J. P. (Council for Scientific and Industrial Research, Pretoria (South Africa)). Apr 1970. 9p. NTIS (U. S. Sales Only).

Radioactive pulses are emitted radially inward from a ring (d = 18 cm) and radioactivity measured by two detectors placed just off-perpendicular 15 cm from the center of the ring. This probe operates satisfactorily in the range 5 to 30 mm/sec and is capable of determining flow direction within 5°. (auth) (INIS)

21244 TEMPERATURE FIELD IN A NONISOTHERMAL TWO-PHASE FLOW. Ibragimov, M. Kh.; Sabelev, G. I.; Sidorov, V. I. This paper was summarized in At. Energ. (USSR); 28: 421-2 (May 1970) as paper No. 386/5395. (In Russian).

In the operation of power installations with a liquid heat-transfer agent a certain amount of gas may enter, which changes the conditions of heat transfer. An experimental investigation of the effect of the gaseous phase on the heat transport in the flow of a two-phase mixture of water and air is described. The experiments were conducted in a vertical square channel having a cross section of 30×30 mm^2 and a length of 1800 mm with four-sided heating at a constant heat flux of $q = 1 \cdot 10^4$ kcal/m^2/hr to the wall. Air was injected into the bottom entrance chamber of the channel. The wall temperature was measured by three micro-thermocouples; the temperature in the liquid flow was measured by a movable thermocouple having a junction diameter of 0.2 mm. (auth)

21245 EFFECT OF INJECTION SPEED ON THE TRACER CONCENTRATION CURVES. Hubert, Jerzy (Inst. of Nuclear Tech., Krakow). Nukleonika; 15: 371-6(1970).

Determination of the flow velocity of fluids using the radiotracer pulse technique requires an approximation of the real tracer introduction boundary conditions by a function either of space coordinates or of time. If the ratio of tracer introduction speed to flow velocity is high, the first choice is recommended, if it is small—the second. For the second case, the tracer concentration function has been found theoretically, and is compared with earlier known concentration function for the first type of the boundary condition approximation. The new function shows more asymmetry and can be used to predict earlier arrival of activity peaks at the detection points. (auth)

Isotope Technology

Refer also to abstracts 20988, 21158, 21229, 21233, 21235–21237, 21243, 21245, 21422, 21465, 21687, 21781, 21783, 21787, 21792, 21848, 22016, 22062, 22135, 22167, 22394, 22651, and 23360.

21246 (SC-PR-70-882) AEROSPACE NUCLEAR SAFETY PROGRAM. Quarterly Report, October 1–December 31, 1970. Clark, A. J. Jr. (Sandia Labs., Albuquerque, N. Mex.). Dec 1970. 28p. Dep. NTIS.

The research, development, support, and test activities in Sandia Laboratories Aerospace Nuclear Safety Program from October 1 through December 31, 1970 are described. Five Sandia trajectories were selected for thermal stress analysis of the Pioneer heat shield; thermal stress calculations were carried out for two of the trajectories, and the results indicated no thermal stress failure of the heat shield; however, the remaining three trajectories will generate much more severe thermal stresses. The low and high yield overpressure tests of complete Pioneer RTGs were conducted; in both tests, the generator housing and the graphite heat shield were shattered and the bare capsule was found intact. The low velocity fragment test of a Pioneer capsule was conducted; the capsule was recovered intact, but the clad was breached and the strength member was exposed. Two liquid fire tests were performed using Pioneer capsules; neither capsule was significantly damaged. The final Safety Analysis Summary for HAVE SINEW-1 is being prepared. The handling, installation, and health physics procedures for ^{182}Ta are complete. The flight trajectory for HAVE SINEW-1 was fixed by Atlantic Research, and the flight environment analysis has been started for each of the five different heat sources. (L.C.L.)

21247 (TID-24270, pp C.23-36) CESIUM SOURCE AT EL VERDE. Odum, Howard T.; Drewry, George (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

A semiportable 10,000 curie cesium source was constructed by the American Nuclear Corporation, Oak Ridge, Tennessee, for environmental irradiation and was moved into position in the rain forest by helicopter. The capsule containing the cesium powder was fixed to the underpart of a lead plug, which was elevated electrically by controls at the El Verde field station and could be returned to its lead pig in three ways: by electrical down drive; by drop when power was interrupted, releasing a magnetic clutch; and by mechanical pull of a release hook from a wire terminal at 400 ft. Excluding several interruptions, the total radiation exposure was 92.8 days (2228 hr). The radiation field was 9.0 mr/hr at the 160 m perimeter fence and 0.12 mr/hr at the 500 m warning line. The background was 0.0087 mr/hr beyond 1000 m. Qualitatively, most of the radiation at 500 m was less than 0.1 MeV. (auth)

21248 DEVELOPMENT OF ISOTOPE TECHNIQUES IN WEST GERMANY. Giese, K. A. Atomwirt., Atomtech.; 15: 564-6 (Dec 1970). (In German).

Data on radioisotopes for the period from 1964 through 1969 are tabulated and discussed. Application of radioisotopes is largest and grows fastest in industry; then follows medicine, and finally research. Isotope production in West Germany is neglected and, therefore, import by far exceeds export. Thus far, emphasis rests on the labeling of compounds, such as pharmaceuticals and biochemicals. Great advances are being made in the production of equipment for measuring and monitoring radioisotopes; in this particular field, export exceeds import. Although the future of radioisotope techniques appears bright, both government and industry fail to take full advantage of available possibilities. (H.B.G.)

21249 GERMAN FOREIGN TRADE OF RADIONUCLIDES FOR 1969. Atomwirt., Atomtech.; 15: 597-8(Dec 1970). (In German).

Results of a survey are tabulated on German import and export of radionuclides for the year 1969. Listed are the types of radionuclides above 50 Ci, the total activity, and the various countries involved. With respect to import, tritium represents the largest amount with more than 22,000 Ci followed by iridium-192 with approximately 10,000 Ci. As far as activity is concerned, France occupies the leading position as point of origin because of the large amount of tritium; Great Britain occupies second place. In regard to various single isotopes, the leading country of origin is Great Britain followed by the USA. During 1969, for the first time, tritium and ^{14}C were received from the USSR. (H.B.G.)

21250 APPLICATION OF RADIOACTIVE ISOTOPES TO THE INVESTIGATION OF SAND-MOVEMENT IN THE COASTAL RANGE. Meyn, Guenter (Bundesanstalt fuer Wasserbau, Hamburg). Atomkernenergie; 17: 63-6(Feb 1971). (In German).

The advantages of using radioactive tracers for investigating sand movement are presented. A procedure for labeling large quantities of sand with ^{51}Cr is described in detail. Tracing of labeled sands is disturbed by the contents of natural radioactive material in the sea bottom. By chemical separation of the tracer material and by analysis of the measured radiation the sensitivity of detection of the tracer can be improved considerably. A chemical process for separation of chromium from soil samples is described. The method of γ-spectrometry is more simply practicable and more universally applicable. (auth)

21251 NEW TYPE OF APPARATUS FOR THE DETERMINATION OF THE THERMAL DIFFUSION FACTOR. Oost, W. A.; Haring, A. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Z. Naturforsch.; 25a: 1879-82(Dec 1970).

An apparatus is presented which gives a precisely known multiplication of the elementary effect in thermal diffusion experiments, avoiding the drawbacks of the swing-separator. This is achieved by using a different method of concentration nivellation than customary with the swing-separator, viz. thermosyphon action. (auth)

21252 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGING METHODS AND APPARATUS. (to Packard Instrument Co., Inc.). British Patent 1,222,589. 17 Feb 1971. Priority date 16 May 1967, Finland.

An improved heat exchanger for condensable vapors provides

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an extremely high heat transfer with only a small volume and surface area and in a very short period of time. The exchanger is particularly applicable to condensation of the products of combustion of radioactive samples, such as for isotope tracer studies. The heat exchanger comprises a straight tube made of thermally conductive material and has an inside diameter of <0.1 in. (B.L.M.)

21253 METHOD AND APPARATUS FOR PROCESSING FLUID MATERIALS PARTICULARLY IN THE PREPARATION OF SAMPLES FOR RADIOACTIVE ISOTOPE TRACER STUDIES. (to Packard Instrument Co., Inc.). British Patent 1,222,587. 17 Feb 1971. Priority date 16 May 1967, Finland.

An apparatus for use in radioactive isotope tracer studies comprises a combustion chamber for burning a sample of material containing the radioactive isotope to produce combustion products that are gaseous in form and contain the isotope. These gaseous products are continually discharged from the combustion chamber, condensed, and collected. Separation means are provided for separating the condensed vapors containing the radioactive isotope tracer from the bulk of the other combustion products. Oxygen is supplied to the combustion chamber during the burning at a controlled rate, and means are provided in connection with the combustion chamber for terminating the oxygen supply and initiating an inert gas supply to the combustion chamber on completion of burning of the material. (B.L.M.)

21254 ISOLATION OF ^{13}C. Schwind, R. A. (Mound Lab., Miamisburg, Ohio). Chem. Process Eng.: 50: No. 7, 75-9(Jul 1969). (MLM-1656-J).

Rare carbon-13 is currently separated in limited quantities from an abundant carbon-12 source. For scaled-up production to meet demands of a potentially large market, separation processes such as thermal diffusion, gaseous diffusion, distillation, and chemical exchange are evaluated. It is concluded that thermal diffusion should be used for small-scale separations and that distillation of carbon monoxide should be used for the production rates greater than 200 g/yr of ^{13}C. (auth)

Materials Testing

Refer also to abstracts 21237, 21240, 21241, 21277, 21278, 21286, 21327, 21465, 21466, 22006, 22069, 22074–22076, and 22207.

21255 (ANL-7738) CORRELATING THE DYNAMIC PLASTIC DEFORMATION OF A CIRCULAR CYLINDRICAL SHELL LOADED BY AN AXIALLY VARYING PRESSURE. Youngdahl, Carl K. (Argonne National Lab., Ill.). Oct 1970. Contract W-31-109-eng-38. 81p. Dep. NTIS.

To determine the localized plastic deformation of a pipe or tube produced by a dynamic loading that exceeds the yield load only briefly, it is important to know the effect of the spatial and temporal shapes of the pressure pulse on the final deformation. This is particularly true in computer or laboratory simulations of reactor accidents, where it is impossible or impractical to reproduce the actual loading conditions. It is shown that the dynamic plastic deformation produced by an arbitrary load shape (spatial) and an arbitrary pulse shape (temporal) can be correlated by three parameters — the impulse, a load-shape parameter, and a pulse-shape parameter. These parameters are defined in terms of integrals of the pressure and are consequently insensitive to inaccuracies in experimental measurements. (auth)

21256 (BNWL-SA-3758) TECHNIQUES FOR NONDESTRUCTIVE EVALUATION OF RADIOACTIVE WASTE CAPSULE END CAP WELDS. Crowe, J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. 20p. Dep. NTIS.

Solid radioactive waste storage requires a high degree of container integrity. The techniques developed to nondestructively inspect end cap welds for cesium and strontium waste containers are described. Ultrasonic methods were defined for locating weld anomalies and acoustic emission techniques are currently being evaluated as an additional method to monitor weld quality. Initial ultrasonic and acoustic emission data taken with prototype equipment have exhibited good correlation with destructive analysis of sample capsule welds. The ultrasonic inspection system is designed to incorporate a novel data presentation technique. The ultrasonic scanning and data readout system produce a readable, easy-to-interpret record of the weld inspection. The scanning technique can be adapted to X–Y recorder printout or high speed CRT mapping methods. Future development areas are suggested which could extend the recording method to present depth-of-flaw or signal amplitude information in other ultrasonic inspection applications. (auth)

21257 (LA-4590) MASKED EDDY CURRENT PROBE FOR DETECTION OF ROVER FUEL ELEMENT COATING CRACKS. Ford, R. M.; Strong, R. D. (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 5p. Dep. NTIS.

A masked probe has been designed to provide eddy current inspection of the protective coating quality on Rover fuel elements. The probe design and electronic circuitry for the inspection equipment are described. Typical results of inspections are shown and discussed. (auth)

21258 APPLICATION OF NEUTRON RADIOGRAPHY IN THE NONDESTRUCTIVE EXAMINATION OF METALS AND COMPOSITES. Spowart, A. R. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). pp 369-76 of Physical and Fabrication Metallurgy. /Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970).

From 9th Commonwealth Mining and Metallurgical Congress, London, England. See CONF-690561-(Vol.4).

The basic principles of neutron radiography are introduced and compared with those of x-radiography. Applications of these principles to the non-destructive testing of nuclear fuels, to penetration in metals and to the detection of hydriding are illustrated. The development of a transportable neutron radiography equipment which is independent of a nuclear reactor is outlined. (auth) (UK)

21259 INDUSTRY-SPONSORED PROGRAMS. Bailey, Eugene C. (Commonwealth Edison Co., Chicago). Nucl. Met., Met. Soc. AIME; 16: 39-47(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

Edison Electric Institute and the Tennessee Valley Authority under the operation of the Electric Research Council are financing a program for the electric utility industry being carried out by Southwest Research Institute and many competent subcontractors to support the development of inservice inspection programs for nuclear reactor vessels. This industry-sponsored program is a part of the Heavy-Section Steel Technology Program developed by the Pressure Vessel Research Committee of the Welding Research Council in response to the concern expressed in a letter to the Atomic Energy Commission from its Advisory Committee on Reactor Safeguards regarding the credibility of a sudden major pressure vessel failure. That part of this industry-sponsored program relating to acoustic emission supplements and continues research and development work which had been initiated and supported previously by the Atomic Energy Commission. That part relating to remote operation of ultrasonic inspection equipment supplements and continues work initiated and carried on by varied groups in this country and overseas. A recently undertaken part of this industry-sponsored program supports the development of ultrasonic holography, an imaging method which may provide an ideal tool for inservice inspection of reactor coolant pressure boundary materials. This inservice inspection program for nuclear reactor vessels was authorized during 1967. Fund raising and contracting were substantially completed so that work started in 1968. The program is scheduled for completion in 1971. (auth)

21260 NONDESTRUCTIVE TESTING TECHNIQUES APPLIED TO IN-SERVICE INSPECTION. Reinhart, Eugene R.; Wylie, Robert D. (Southwest Research Inst., San Antonio). Nucl. Met., Met. Soc. AIME; 16: 199-217(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

A compilation of work performed by various laboratories under the Edison Electric Institute (EEI) and Tennessee Valley Authority Research Program RP 79, "In-Service Inspection Program for Nuclear Reactor Vessels," is presented which represents the work completed from September 1, 1969 to March 1, 1970. This program is used to develop basic nondestructive testing techniques initiated by the Atomic Energy Commission (AEC) and others, in order to adapt this technology to the specific needs of monitoring the integrity of pressure boundaries of operating nuclear steam generating units. The various work phases are being carried out at a number of organizations and the overall program is being managed by Southwest Research Institute (SwRI). (auth)

21261 EVALUATION OF PERIODIC PROOF TESTING AND WARM PRESTRESSING FOR NUCLEAR REACTOR PRESSURE VESSELS. Yukawa, Sumio (General Electric Co., Schenectady, N. Y.). Nucl. Met., Met. Soc. AIME; 16: 250-68(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

The merits and limitations of these procedures as they might be used to enhance the fracture reliability of current generation light water-moderated reactor pressure vessels are reviewed and critically assessed. The available material properties information and results fracture analysis indicate that proof testing as a

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means of validating the absence of specific size flaws has limitations. Analysis results indicate that proof tests should be viewed primarily as a test of overall system pressure tightness and only secondarily as providing a measure of subcritical flaw sizes. The pre-service hydrostatic test currently specified for nuclear vessels is valuable from this viewpoint. However, it is judged that subsequent, periodic in-service proof tests would provide only marginally small increments of information, and their use as a general procedure for nuclear vessels does not seem warranted or required. Positive benefits of warm prestressing have been demonstrated in a number of laboratory tests and in principle, this technique has considerable value in enhancing the fracture capability of nuclear vessels. However, recent study results have shown that the beneficial effects may be reduced under actual vessel operational conditions such as with prolonged thermal and/or radiation exposure. Until such effects are better understood, the value of warm prestressing is necessarily limited and cannot be completely depended upon. Both procedures are useful only to the extent that the stressing conditions imposed match the operational stresses in both sense and magnitude. Instances where this may not apply are discussed. (auth)

21262 INSPECTION AND TEST OF ZIRCALOY CLADDING TUBES. Onishi, Tadatoshi; Tanaka, Yoshiro (Kobe Steel, Ltd., Japan). Kobe Seiko Giho; 20: No. 2, 42-7(Apr 1970). (In Japanese).

The safety of a nuclear reactor is closely related to the integrity of Zircaloy cladding tubes when these are used. In this respect, the inspections and tests must be carried out accurately on a number of items under optimal inspection or test conditions. The inspection and testing of Zircaloy cladding tubes are described: supersonic flaw detection including characteristics of the probes and optimal incident angles; measurement of the dimensions by a micrometer, by an air micrometer, and by ultrasonic technique; measurement of the straightness; extension rate in the tensile test, influencing the measurement; direction of the hydride, affecting the expansion after autoclave treatment; and corrosion testing. (Japan)

21263 THICKNESS MEASUREMENTS IN ALLOYS USED FOR ADVANCED GAS TURBINE ENGINE AIRFOILS. Honeycutt, C. R.; Sattler, F. J. (TRW, Inc., Cleveland). Mater. Eval.; 29: 51-8; 63(Mar 1971).

Advanced gas turbine engine blades and vanes are being made from cast superalloys with intricate coolant passages. These components have critical thickness requirements which must be maintained over the entire airfoil. Due to the size and configuration of the castings, conventional test methods such as eddy current and resonance ultrasonics do not provide sufficient test accuracy. Mechanical gaging is limited by the inaccessible nature of the coolant channels. A program to develop test methods for turbine blade and vane wall thickness measurements is described. Two test methods have been evaluated for these applications. A high resolution pulse-echo ultrasonic thickness gage capable of measuring thicknesses down to 0.010-in. has been used. A thermoelectric comparator has been evaluated for measuring thickness utilizing the thermal properties of blade materials. Results are presented comparing the thickness range on which these methods are usable for three nickel-base alloys, and the accuracy of the measurements for the two methods. (auth)

21264 REACTOR-MATERIALS INSPECTION BY NEUTRON RADIOGRAPHY. Plummer, A. M. (Battelle Memorial Inst., Columbus, Ohio). Reactor Technol.; 14: 1-6(Spring 1971).

Neutron radiography as a relatively new nondestructive method for testing reactor materials is discussed. The three basic components required to perform neutron radiography, i.e., a neutron source, collimating system, and imaging device, and applications of the method for fuel-capsule surveillance are described. (L.C.L.)

21265 MODERN LOOK OF NONDESTRUCTIVE TESTING. Peck, Eliot S. Mfg. Eng. Manage.; 66: No. 3, 33-7(Mar 1971).

A review of nondestructive testing methods is presented in which applications of the various methods are discussed and evaluated. Information and discussions are included on magnetic particle testing, fluorescent and penetrant testing, eddy current testing, ultrasonic testing, and x and gamma radiation testing. The future of nondestructive testing is also evaluated. (J.R.D.)

Radioactive Material Handling

Refer also to abstracts 20911, 20938, 21000, 21078, 21079, 21081, 21082, 21118, 21119, 21121, 21123, 21126–21129, 21143, 21238, 21256, 21729, 21730, 21732, 21733, 21769, and 22210–22212.

21266 (AEC-tr-7218) METHOD FOR DEACTIVATING CONTAMINATED SURFACES BY FILM. Robev, S. K.; Sumerska, T. B.; Todorov, S. L.; Krstanov, D. K.; Marinova, Ts. I. Translated by John D. Kaser from pp 751-7 of Symposium on Practices in the Treatment of Low and Intermediate Level Radioactive Waste, Vienna, December 6–10, 1965. 5p. (CONF-651202-22). Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 25337.

21267 (BARC/INF-1) RADIOACTIVE WASTE MANAGEMENT. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 6p. NTIS (U. S. Sales Only).

Suitable processes and methods for handling, storage, treatment, and disposal of radioactive wastes as well as decontamination and reclamation of useful equipment and articles are described. Solid combustible wastes are burned in a special incinerator and the gases are released to the atmosphere through a high stack. The ash residues are mixed with concrete and stored as solid blocks in steel drums. The non-combustible solid wastes are compressed to a smaller volume and stored in steel drums. High-level solid wastes are stored in specially protected underground trenches. The liquid wastes are treated in a plant with a capacity of 50,000 gallons per day discharging effluents into Trombay Bay at a level below the permissible concentration. High-level liquid wastes are stored in stainless steel tanks with cooling coils and encased in thick concrete. It is indicated that certain types of glasses will be highly suitable for converting high-level liquid wastes into a non-leachable solid mass for better storage. Facilities are also available at the decontamination center for decontaminating all protective equipment such as clothing, shoes, and gloves. Decontamination of special tools used in the reactors is effected by the ultrasonic cleaning machine and dunk washer. The development of air filters and respirators which have found wide use not only in radioactive installations but also in pharmaceutical and electronics industries is described. (INIS)

21268 (CONF-700816-(Vol.2)) PROCEEDINGS OF THE ELEVENTH AEC AIR CLEANING CONFERENCE HELD IN THE FEDERAL BUILDING, RICHLAND, WASHINGTON, AUGUST 31–SEPTEMBER 3, 1970. First, Melvin W.; Morgan, James M. Jr. (eds.) (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab. Division of Reactor Development and Technology (AEC), Washington, D. C.). Dec 1970. 411p. Dep. NTIS.

Thirty papers on air cleaning were presented at the conference and are included in Vol. 2 of the proceedings. A separate abstract was prepared for each of 27. Three papers appeared previously in NSA. For abstracts of these see 24: 44793, 24: 47933, and 24: 51238. (L.C.L.)

For abstracts of individual papers see: 20928, 20963, 20964, 21000, 21078, 21231, 21269–21279, 21546, 21686, 21836, 22210–22212, 23308, 23330, 23331, and 23387.

21269 (CONF-700816-(Vol.2), pp 551-67) IODINE BEHAVIOR AND CONTROL IN PROCESSING PLANTS FOR FAST REACTOR FUELS. Yarbro, O. O.; Crouse, D. J.; Cathers, G. I. (Oak Ridge National Lab., Tenn.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

One of the major problems confronting the development of a reprocessing system for fast reactor fuels is the removal of radioiodine from plant effluents. The Pu content and resulting high specific value of fast reactor fuels make it economically desirable to process after as little as 30 days' decay. This reduced decay time requires plant retention factors for I approaching 10^8, and will place demands on the I removal equipment four to five orders of magnitude greater than proven technology can guarantee. Development work at ORNL is directed toward a better understanding of basic I behavior and the development of I removal systems capable of meeting these demands. A number of experimental systems including both aqueous scrubbers and dry adsorbers have demonstrated decontamination capabilities in excess of 10^4. Small-scale, short-term engineering demonstrations using an actual dissolver off-gas stream as feed have produced overall decontamination efficiencies in excess of 10^6, and have indicated that the individual component efficiencies are not significantly reduced when several components are operated in series. Work is continuing on the many remaining uncertainties both in understanding basic I behavior and in demonstrating long-term dependability of attractive removal systems. (auth)

21270 (CONF-700816-(Vol.2), pp 621-34) SELECTIVE ADSORBENT SAMPLING SYSTEM FOR DIFFERENTIATING AIR-

BORNE IODINE SPECIES. Keller, J. H.; Duce, F. A.; Maeck, W. J. (Idaho Nuclear Corp., Idaho Falls).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

Atmospheric sampling devices capable of differentiating and measuring the various species of airborne iodine are required to interpret the behavior of airborne iodine under water-reactor accident-release conditions. To date, most sampling devices have consisted of a series of adsorbents which invariably include a silver metal surface for the retention of inorganic iodine and a charcoal bed for the retention of organic iodides. Operating experience with these types of samplers has shown the iodine adsorption efficiency of silver metal surfaces to be incomplete for submicrogram levels of incident elemental iodine and for hypoiodous acid in humid atmospheres. The sampler being developed in our laboratory is based on a high-efficiency particulate filter and a series of three inorganic material adsorbents that separate the containment atmosphere sample into the following four fractions in the order of sample flow through the sampler: noniodine particulate, elemental iodine, nonelemental inorganic iodine (hypoiodous acid) and organic iodine. The requirement for an adsorbent for hypoiodous acid is based on our finding that hypoiodous acid, which has a long airborne half-time, is the major inorganic iodine species after the initial washout of elemental iodine from a steam-air atmosphere. Because hypoiodous acid is only partially retained by silver metal surfaces in conventional samplers, it would collect on the charcoal bed resulting in erroneously high values for methyl iodide. (auth)

21271 (CONF-700816-(Vol.2), pp 635-52) DETERMINATION OF THE INTERPARTICLE VOID VOLUME IN PACKED GRANULAR BEDS FROM AEROSOL BREAKTHROUGH CURVES. Underhill, Dwight W.; Reist, Parker C.; Hurley, Ronald (Harvard School of Public Health, Boston, Mass.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

Accurate measurement of the interparticle void volume is required for understanding the mass transfer phenomena which take place in packed granular beds. For many beds, conventional measurement techniques are unsatisfactory because of inaccuracies or because they may alter the bed in some way. Here it is shown that the interparticle porosity of a packed bed may be determined accurately from the breakthrough curve of a flowing stream of aerosol. This method uses the statistical moments of the aerosol breakthrough curve. From the zeroth moment, a rate constant is found which describes the rate of aerosol removal by collisions between the aerosol particles and the granules in the packed bed. The analysis proceeds by using this collision rate factor to remove the effect of aerosol loss from the breakthrough curve data. Then from the normalized breakthrough curves obtained in this manner the first and second statistical moments are calculated. The interparticle porosity is determined directly from the first statistical moment. The second statistical moment, used in combination with the first statistical moment, determines the effective interparticle diffusion coefficient. Breakthrough curves obtained from beds of Raschig rings and Berl saddles were analyzed by this method and compared to results determined from conventional porosity measurement techniques. (auth)

21272 (CONF-700816-(Vol.2), pp 738-50) DEEP BED ACTIVATED CARBON FOR LIQUID, SOLID, AEROSOL, AND GASEOUS FILTERS. Kovach, J. L. (North American Carbon, Inc., Columbus, Ohio); Newton, R. G. (MSA Research Corp., Evans City, Pa.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The design of a filtration system for removing both particulate matter and gaseous radioactive contaminants from radioactive gaseous wastes is described. The system uses horizontally placed 15 in. deep carbon beds consisting of coarse activated carbon followed by HEPA filters. The results of efficiency tests for particulate removal and for radioactive iodine adsorption are presented. It was concluded that: the design is simple and advantageous because the single container eliminates extensive gasketing and, therefore, potentional leaks; the overall iodine adsorption efficiency of the full bed depth is higher than the conventional absorber efficiency; the deep filter system permits in situ regeneration of a weathered carbon bed by the introduction of hot inert gas; the hazard of disposal of the contaminated bed is considerably reduced; and the deep bed filter design permits easy continuous monitoring of decontamination efficiency, even during accident conditions, by monitoring activity in the absorber at various levels. (L.C.L.)

21273 (CONF-700816-(Vol.2), pp 751-65) ATMOSPHERIC PARTICLE PENETRATION THROUGH HIGH-EFFICIENCY FILTERS. Lieberman, A. (Royco Instruments, Inc., Menlo Park, Calif.); Scott, R. D. (HEPA Corp., South El Monte, Calif.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

Penetration of atmospheric particles through filters with rated DOP removal efficiencies ranging from 90% to 99.97% was studied. Exact data on DOP removal are obtained with a Q76 penetrometer. Atmospheric particle number concentrations were determined in the size ranges 0.3 to 0.5 μm; 0.5 to 0.7 μm; 0.7 to 1.0 μm and 1.0 to 3.0 μm, up and downstream of the filters. Relationships between DOP penetration and atmospheric particle penetration are discussed. The effect of variations in filter face velocities is included. (auth)

21274 (CONF-700816-(Vol.2), pp 766-9) GOVERNMENT-INDUSTRY MEETING ON FILTERS, MEDIA, AND MEDIA TESTING. Anderson, W. L. (Naval Research Lab., Washington, D. C.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The proceedings of the 11th annual government-industry meeting on the development and testing of high-efficiency particulate filters are reviewed. The subjects discussed included: military specifications for high-efficiency filters; use of special glass fibers; irradiation tests on HEPA materials, development of HF-resistant media; moisture resistance testing, filter media caliper, and penetrometer calibration. (L.C.L.)

21275 (CONF-700816-(Vol.2), pp 770-90) IGNITION OF CHARCOAL ADSORBERS BY FISSION PRODUCT DECAY HEAT. Shields, R. P. (Oak Ridge National Lab., Tenn.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The problem of estimating maximum temperatures in a charcoal bed has been set up so that the sensitive parameters, the insensitive parameters, the parameters that need to be measured and the parameters that might usefully be modified to increase the safety of a system can be clearly defined. A simple code has been written which calculates maximum temperatures (or other temperatures) in a bed as a function of time and the pertinent parameters. The code is based on an infinite slab model and should be valuable because it is simple and is quite accurate at higher velocities. A more complicated computer code has also been assembled which is based on a three-dimensional model. This code enables one to mathematically describe a tray-type charcoal adsorber quite accurately, including the heat sink and conduction paths offered by the steel screens and frames. This more detailed thermal analysis is required to estimate temperatures at very low gas flows. Both codes will soon be available. (auth)

21276 (CONF-700816-(Vol.2), pp 791-806) NEW FIRE PROTECTION SYSTEMS FOR FILTER PLENUMS. Domning, W. E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

A fire test facility was constructed consisting of a glovebox and a filter plenum which contained 12 filters. The purpose of this facility is to study the effects of a fire originating within the glovebox on the entire glovebox system which includes the filter plenum. The details of construction of the facility are shown and the results of several experiments are discussed to show the capability of the facility. Exhaust air temperatures from burning shielded gloveboxes range between 1530 to 1620°F. In order to maintain filter integrity under these conditions it is necessary to cool the air stream prior to filtration. The most successful air cooler tested has been a water spray-cooled baffle inserted upstream of the initial stage of filtration. This baffle was effective in cooling 1672°F incoming air to 125°F within one minute after actuation. (auth)

21277 (CONF-700816-(Vol.2), pp 824-31) RETESTING SELECTED USED HEPA FILTERS TO DETERMINE OPTIMUM FILTER LIFE UNDER VARIOUS OPERATING CONDITIONS: A PROGRESS REPORT. Sims, L. L. (Hanford Environmental Health Foundation, Richland, Wash.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

A program is described which is being undertaken by the Hanford Environmental Health Foundation to gather performance data on HEPA filters at the termination of their use in AEC facilities and to compare these data with the performance of the same

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filters, tested under nearly identical conditions, prior to their use. No comparative data on filter performance before and after use are given. (L.C.L.)

21278 (CONF-700816-(Vol.2), pp 837-8) NASA EXPERIENCE (POLICY) WITH HEPA FILTERS. Keigher, D. J. (National Aeronautics and Space Administration, Washington, D. C.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The uses of HEPA filters at various NASA installations, and two NASA specifications for the installation and testing of HEPA filters are briefly discussed. (L.C.L.)

21279 (CONF-700816-(Vol.2), pp 839-40) RECENT SIGNIFICANT CLEAN ROOM FIRE. Keigher, D. J. (National Aeronautics and Space Administration, Washington, D. C.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

A fire in a one-story brick and plywood building used as a clean room for cleaning and packaging delicate hardware for NASA applications is described. (L.C.L.)

21280 (DPSPU-71-124-2) SAFETY SUMMARY REPORT, TRITIATED HEAVY WATER SHIPMENTS UNDER SPECIAL CONDITIONS (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Scaggs, R. A. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Feb 1971. Contract AT(07-2)-1. 18p. Dep. NTIS.

Drums of tritiated heavy water are shipped in refrigerated railway cars in a manner that protects public health and safety. Because drop and thermal tests on the railway car are impractical, each shipment is accompanied by at least two designated escorts whose function is to provide administrative controls and to assist authorities in the event of fire, accident, leakage, or unusual delay involving the shipment. Methods and regulations for shipping tritiated heavy water are presented. (auth)

21281 (GULF-RT-10459) APPLICATION OF PHOTOINDUCED REACTIONS TO NUCLEAR MATERIALS SAFEGUARDS PROBLEMS. Quarterly Progress Report, July 1–September 30, 1970. Bramblett, R. L.; Ginaven, R. O.; Gozani, T.; Hyde, A. T.; McMillan, J. I.; Rundquist, D. E.; Trimble, G. D. (Gulf Radiation Technology, San Diego, Calif.). 23 Dec 1970. Contract AT(04-3)-167. 65p. Dep. NTIS.

The work performed on the development of techniques and hardware for the quantitative assay of nuclear materials is described. The nuclear materials measurement techniques are being developed for application to existing problems in the nuclear reactor fuel cycle, particularly for measurements that cannot be performed by wet chemistry. The approach is based on the use of photonuclear reactions initiated by an electron linear accelerator, Linac, and resulting in characteristic responses from nuclear materials in samples of arbitrary geometry. Application of these nondestructive measurements to presently unmeasured items in the fuel cycle will improve the control of nuclear materials that is required in safeguarding against diversion. To attain the earliest possible application to problems in the nuclear fuel industry, a field testing program was initiated as soon as technical feasibility of the Linac approach was established. A transportable Linac was designed to meet the requirements for field operation. Construction of the Linac was completed in early 1970. After a short testing period, the Linac and other equipment, including a barrel scanner and an on-line computer, were installed into a conventional instrumentation trailer to form a transportable nuclear materials assay system (GAMAS). The first field tests of this system were performed and the results of in-the-field measurements of the nuclear material contained in 55-gallon drums of otherwise unmeasurable scrap are reported. The measurements performed in the field test operations are supported by development work on active techniques used on one of the fixed installation Linacs, and by work on measurement of the naturally-occurring radiations from nuclear materials using highly developed instrumentation. A scanning procedure that minimizes attenuation effects in both types of measurement was developed for large samples. (auth)

21282 (IAEA-R-566-F) UTILIZATION OF KOREAN CLAYS AND MINERALS FOR RADIOACTIVE LIQUID WASTE TREATMENT AND DISPOSAL. Lee, Sang Hoon (International Atomic Energy Agency, Vienna (Austria)). Dec 1969. 19p. NTIS (U. S. Sales Only).

Results are given of a study on the utilization of Korean domestic clays and minerals such as kaolinite, montmorillonite, and vermiculite groups, in the treatment of radioactive liquid waste. Mineralogical studies on chemical and physical properties of the representative domestic clays were experimentally evaluated by chemical analysis, particle distribution measurement, x-ray analysis, and electrophoretic mobility. The ion exchange capacities and the sorption of the radionuclides strontium-90 and cesium-137 were also studied. In order to make the most effective use of the clay in the liquid waste treatment, effort was concentrated on the pretreatment of the clays which leads to more economic and simpler methods. The model test to optimize the plant scale application using domestic clays was introduced as a preliminary study of the experiment. (INIS)

21283 (IAEA-R-741-F) DEVELOPMENT OF SAFEGUARDS PROCEDURES FOR SCRAP PROCESSING ACTIVITIES AND ASSOCIATED STUDIES. Johnson, E. R.; Gammill, A. M. (International Atomic Energy Agency, Vienna (Austria)). 1 Oct 1969. 5p. NTIS (U. S. Sales Only).

A brief survey of the types of scrap materials expected in future years and a survey of available scrap processing technology is given. The scrap segregation and packaging procedures are recommended for reducing the prospect of shipper-receiver discrepancies between scrap generators and scrap processors, facilitating the early processing of scrap materials, reducing the uncertainty of the uranium and/or plutonium content of scrap materials and minimizing the cost of scrap processing. These recommendations are followed by procedures for effective safeguards inspection of scrap processing facilities. (INIS)

21284 (RISO-231) LEAD CONTAINERS IN THE DANISH AEC PACKAGINGS FOR RADIOACTIVE MATERIAL. Domanus, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug 1970. 45p. Dep. NTIS (U. S. Sales Only).

Three types of lead containers are at present used in the Danish AEC packagings for radioactive material: open type (5 and 10 mm), semi-closed type (20 and 30 mm) and closed type (45, 60, 80, and 100 mm). The open-type containers are used in tin cans as containment vessels in cardboard packagings. The others are used in the wooden packagings. The closed-type lead containers can be made leaktight and then used as containment vessels. Suitable methods for that purpose that have been tested and proved satisfactory are described. Radiation-shielding properties of the lead containers are discussed and a description of the evaluation of those properties given. Equipment and procedure for radiation testing by the autoradiographic and radiometric method are described, and the test findings are discussed. Conclusions are drawn regarding the future use of all types of lead containers, and suggestions are made for extension of the open-type series, discontinuation of the use of the semi-closed series and extension of the closed-type series after it has been made leaktight. (auth) (Denmark)

21285 (STI/PUB-260(Vol.1)) SAFEGUARDS TECHNIQUES. VOLUME I. Proceedings Series. Proceedings of a Symposium Held in Karlsruhe, Germany, 6–10 July 1970. (International Atomic Energy Agency, Vienna (Austria)). Dec 1970. 625p. (In several languages). (CONF-700701-(Vol.1)). IAEA $17.00.

Forty papers were presented at the conference and are included in Volume 1. A separate abstract was prepared for each of thirty-six. Four papers were previously abstracted in NSA. For abstracts of these see 24: 29092, 24: 39177, 24: 48863, and 25: 2417. (L.C.L.)

For abstracts of individual papers see: 21289–21324.

21286 (STI/PUB-260(Vol.2)) SAFEGUARDS TECHNIQUES. VOLUME II. Proceedings Series. Proceedings of a Symposium Held in Karlsruhe, Germany, 6–10 July 1970. (International Atomic Energy Agency, Vienna (Austria)). Dec 1970. 512p. (In several languages). (CONF-700701-(Vol.2)). IAEA $13.00.

Twenty-seven papers were presented at the conference and are included in Volume 2. A separate abstract was prepared for each of twenty-five papers. Two papers were previously abstracted in NSA. For abstracts of these see 24: 48239 and 25: 3649. (J.G.B.)

For abstracts of individual papers see: 20911–20913, 20936–20939, 21238, and 21325–21341.

21287 (STI/PUB-264) MANAGEMENT OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTES. Proceedings Series. Proceedings of a Symposium Held at Aix-en-Provence, France, 7–11 September 1970. (International Atomic Energy Agency, Vienna (Austria)). Dec 1970. 825p. (In several languages). (CONF-700905). IAEA $22.00.

Fifty-three papers presented at the Symposium are included. Separate abstracts were prepared for 50 of the papers. Seven of these are available in translation as JPRS-51948 and are so

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indicated in the abstract. The remaining three papers were previously abstracted for NSA and appeared as 24: 46295, 46454, and 46455. (M.C.G.)

For abstracts of individual papers see: 21114–21129 and 21342–21375.

21288 WHAT IT IS NECESSARY TO KNOW ABOUT THE REGULATION ON THE TRANSPORTING OF RADIOACTIVE MATERIALS. Andre, G. J. Belge Radiol.; 53: 397-404(Sep-Oct 1970). (In French).

Regulations of the International Atomic Energy Agency for the transport of radioactive materials are discussed. The regulations take into account the special hazards of such transport, by considering that its safety must be ensured both by the nature of the packaging and by the marking and labeling of the package. (auth)

21289 MODERN SAFEGUARDS AT REPROCESSING PLANTS AND REACTORS. Haefele, W.; Nentwich, D. (Kernforschungszentrum, Karlsruhe, Ger.). pp 3-21 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

A modern safeguards system based on a material balance, containment and surveillance measures has to be applicable to a fuel cycle rather than a single nuclear facility. Consideration of the fuel cycle as a whole enables various interrelated information to be used advantageously for safeguards purposes. A typical example is the entrance of a reprocessing plant. At this point the identity of the individual fuel elements discharged from a reactor is destroyed. The digital accountability system which could start at the exit of a fabrication plant and extend to the reactor and could be utilized for safeguards also ends at this point. An open accountability system involving measurements has to be used from this point till the end of the fabrication plant to establish the material balance. Although with the help of highly effective containment measures it would be theoretically sufficient to measure uranium and plutonium flows for the first time at the exit of a reprocessing plant after the fuel elements have been discharged from a reactor, it is desirable to measure the uranium and plutonium fuels at the entrance to the reprocessing plant as well. It is shown that such measurements of plutonium can be considerably simplified by taking advantage of fairly straightforward isotopic correlations which exist between the total uranium content of a fuel element at the exit of a fabrication plant and the plutonium produced in this fuel element in a given reactor. The total uranium amount in the fresh fuel element and the ^{235}U to ^{238}U ratio in the same irradiated fuel element after it has been dissolved at the entrance of a reprocessing plant have to be known within an accuracy of ±1% and only a rough estimate of the conversion ratios of the reactor and the burn-up in the fuel element with an accuracy of ±15% need to be known to predict the plutonium production in the same fuel element with an accuracy of about ±2%. Some detailed information is given on the containment measures for the accountability tank at the entrance of a reprocessing plant which is essential for the effective application of material balance measures at that point. (auth)

21290 PROGRESS AND PROSPECTS FOR NUCLEAR MATERIALS SAFEGUARDS. Crowson, D. L. (Atomic Energy Commission, Washington, D. C.). pp 23-34 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

A comprehensive review of United States nuclear materials safeguards was presented at the 1968 International Conference on the Constructive Uses of Atomic Energy in Washington, D. C. Since that time, progress on domestic and international safeguards includes continuing efforts in support of the non-proliferation treaty. Co-operation has continued under the agreement for application of agency safeguards to certain US reactor facilities. Since the 1968 meeting bilateral international agreements between the USA and other countries have changed somewhat and the domestic US nuclear industry has grown and changed in form. Private ownership of nuclear materials was permitted at the time of the 1968 meeting and since that time the United States has begun entering into toll enrichment agreements covering privately owned nuclear materials and by next January will stop entering into nuclear materials lease agreements or purchase agreements for plutonium from power reactor fuel. The Commission has introduced regulatory requirements for safeguarding nuclear materials and additional requirements are under active consideration at this time. In addition, progress is underway on nuclear materials safeguards criteria for fuel cycle plant design and for operating reactors. Growth and change in US safeguards since 1968 have been reflected in studies reported at the 1969 IAEA Panels in Vienna and Tokyo. The utility of criteria for use by inspectors in an effective safeguards system is under active consideration. There have been recent studies and experiments with inspection methods and strategies. Progress has been made on integrated safeguards experiments in facilities processing material of high strategic value. Field experiences include campaigns to remeasure inventories of nuclear materials. Techniques involved passive gamma-ray and neutron measurements on nuclear fuel rods, intermediate process materials and scrap and waste under operating conditions in privately owned processing plants. Recent experience includes completion and initial field operation of vehicles equipped with nondestructive assay instrumentation for measurement of nuclear materials content of various fuel forms: operation of a personnel doorway monitor at a USAEC facility; use of Internal Revenue type seals in US facilities; and a USAEC resident inspection experiment. The Commission has initiated a Plant Instrumentation Program intended to achieve and demonstrate reliability in safeguards assays of plutonium product and highly enriched uranium scrap, reduction or elimination of by-difference determinations in plant inventory, and usefulness of non-destructive measurements during USAEC plant inspections. (auth)

21291 VERIFICATION CONSIDERATIONS. Rometsch, R. (International Atomic Energy Agency, Vienna). pp 35-8 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

In the Non-Proliferation Treaty safeguards are foreseen for the purpose of verification of the fulfillment of the Treaty obligations. Analysing the relevant texts yields the conclusion that in practice production, consumption, or continuous presence of nuclear material in the entire nuclear fuel cycle for peaceful purposes must be verified. For this a large number of data has to be made available on a continuous basis to the safeguards authority. By systematic classification of these data and making use of many correlations between them, the verification task can be fulfilled with a reasonable effort. (auth)

21292 REVIEW OF EXPERIENCE WITH THE APPLICATION AND ADMINISTRATION OF A FULL SAFEGUARDS SYSTEM TO AN OPERATING NUCLEAR POWER STATION. Newman, G.; Vowles, A. F. (Central Electricity Generating Board, Bradwell, Eng.). pp 39-62 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

A brief account is given of the negotiations leading to the application of International Safeguards to Bradwell Nuclear Power Station, Essex, and describes the functions and interrelationship of the organizations involved with the International Atomic Energy Authority, namely, the Central Electricity Generating Board, the United Kingdom Government and the United Kingdom Atomic Energy Authority. Particular reference is made to the role of the Generating Board which is a nationalized industry with specific statutory duties in connection with electricity supply in England and Wales and to the attitude of that organization to the Safeguards Agreement. The basic Safeguards Agreement and its supplementary arrangements are discussed in relation to possible problems in applying such procedures to the Board's nuclear facilities in general. The Bradwell plant is described in some detail, particularly that associated with the fuel route from receipt of the new fuel elements to the disposal of the irradiated fuel so that the particular problems involved in the Safeguards implementation in such a plant may be fully appreciated. The fuel inventory is large, both within the reactors and within the irradiated fuel storage ponds, and the means of stock checking and the use of operational records are described. An account is given of the experience of Safeguards application at Bradwell since 1966, and of the problems faced and the new techniques either evolved or being developed in connection with the implementation of the Agreement. Finally the effect of the application of the Safeguards Agreement upon the normal operation of the plant is dealt with in terms of the work involved, the reaction of the station staff, and the liaison required between the various organizations. (auth)

21293 DANISH SAFEGUARDS RESEARCH AND DEVELOPMENT. Frederiksen, P. (Danish Atomic Energy Commission,

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Risoe). pp 63-71 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

In Denmark all nuclear reactors and all nuclear materials from the United Kingdom and the United States are subject to IAEA safeguards under the safeguards agreement signed in 1965 by Denmark, the United Kingdom and the IAEA, and the safeguards agreement signed in 1968 by Denmark, the United States and the IAEA. A presentation is given of Danish safeguards research into methods and instrumentation which may be used by the IAEA. The system analysis of the safeguards aspects of the DR 3 reactor is described. The flow of nuclear material through the facility and the inventory of highly enriched material are studied with particular attention to the principles of inspection as well as the efficiency of the inspections as function of the cost. Experience with two types of sealed safeguards instrumentation for verification of reactor operation during the period between the inspections is described. One of the methods is based on measurement of integrated thermal power, the other on measurement of integrated neutron flux. The reactor power in MW as a function of time is also recorded in both methods. Non-destructive measurement techniques have been used by the IAEA for verification of the quantity of ^{235}U in unirradiated fuel elements containing highly enriched uranium. Some of the results of the use of this method are mentioned. (auth)

21294 INTEGRAL SAFEGUARDS EXERCISES IN A FABRICATING AND A REPROCESSING PLANT. Kraemer, R.; Gmelin, W.; Von Baeckmann, A.; (and others) (Kernforschungszentrum, Karlsruhe, Ger.). pp 83-104 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Over the past two years 4 integral safeguards exercises have been carried out in the context of fissile material control project at the Nuclear Research Center Karlsruhe: 2 at the reprocessing plant EUROCHEMIC Mol and 2 at the plutonium fabrication plant ALKEM, located on the premises of the Nuclear Research Center Karlsruhe. In this context "integral exercise" means that the whole safeguards system in the particular nuclear plant is investigated under industrial conditions. The point is emphasized to close the nuclear material balance as independently as possible on the basis of independent measurements and analysis performed at a limited number of strategic points. Mol I and II and ALKEM II-experiment were laid out as "diversion free" experiments and containment measures were excluded in order to investigate MUF components, whereas in ALKEM I a small amount of Pu withdrawn by the operator was to be detected by adequate safeguards efforts. Besides these objectives the experiments should demonstrate the present state of development of the instruments and analytical procedures available for safeguards purposes with respect to accuracy and tamper resistance under industrial conditions. Furthermore, experience has been gathered concerning man-hours, analyses and costs necessary for safeguards. In Mol II a new kind of physical inventory-taking has been investigated using isotope analysis of input and product streams, which might be of interest in safeguarding reprocessing plants because requirements of non-intrusiveness are closely fulfilled. The design, performance, and results of these integral exercises are described, and the operational aspects of safeguards emphasized. (auth)

21295 CONTRIBUTION TO SAFEGUARDS STUDIES IN FABRICATION PLANTS. Miranda, U. (EURATOM, Ispra, Italy); Busca, G.; Kloeckner, W.; (and others). pp 105-23 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The controls and control techniques constituting the Krito exercise are described. In this exercise nondestructive measuring techniques were tried out on finished products under field conditions and a series of statistical evaluations were made from the fabrication data. An account is given of the different conversion and fabrication stages undergone by the material, 190 kg of UF_6 enriched to 90% ^{235}U in the preparation of nickelled U metal platelets. The gamma-spectrometry techniques utilized for the control of the finished product are described and the results of the measurements reported. The controls were worked out for the fabrication process as a whole, taking into account: calculation of the material balance to within 2% with a confidence level of 95%, classification of the different types of wastes; limitation of the accumulation of waste of not directly measurable uranium content; estimation of MUF during the fabrication cycle; and studies on the estimation of some statistical parameters. Utilization of gamma-spectrometric techniques for the control of MTR fuel elements: Gamma-spectrometric techniques have been tried experimentally for the determination of the uranium content and isotopic composition of assembled MTR fuel elements with parallel plates. The ^{235}U content is determined by means of gamma-ray emission measurements. The total uranium content is determined by means of gamma-ray attenuation measurements utilizing external sources of ^{51}Cr and ^{141}Ce. These techniques have been tested on several MTR fuel elements of the Ispra I reactor. The results of these measurements are reported. On the basis of these results an apparatus for the gamma-scanning of MTR plates and assemblies has been designed, constructed and tested. This apparatus is equipped with 2 NaI(Tl) detectors connected to a single-channel analyzer and can be manually operated or software controlled. Since October 1969 this apparatus has been utilized for the control of MTR fuel elements under normal inspection conditions. (auth)

21296 APPLICATION OF SAFEGUARDS TECHNIQUES TO A LARGE ZERO-ENERGY REACTOR FACILITY. Brown, F. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Terrey, D. R.; Good, P. T.; (and others). pp 125-38 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Considerable experience in the audit of fissile material stocks has been obtained during IAEA inspection of the fuel stock of a large zero-energy experimental fast reactor. The fuel consists of a large number (10^4) of small, clad plates of thirteen different types, comprising both metal and sintered mixed oxide (U/PuO_2). The plates each contain 20-70 g of fissile plutonium, according to type. A statistical treatment has been devised which permits determination of the sample sizes required for the detection of given levels of diversion with various probabilities; various diversion strategies, both for fuel in store (as individual plates) and in the reactor (made up into experimental fuel elements). A technique has been developed for measurement of the ^{239}Pu content of stored fuel plates by measuring the 384-keV gamma emission using a portable gamma-spectrometer of UKAEA design. Interference from fission-product gamma radiation is considered as a function of irradiation history. It is possible by a special counting technique to distinguish between spontaneous fission neutrons and those neutrons arising from αn reactions and spontaneous fission neutron counting can be used to determine the spontaneous fission rate of fuel plates a short time after withdrawal from the reactor. Since spontaneous fission is due almost entirely to the ^{240}Pu content, the total fissile plutonium may be calculated without prior knowledge of the isotopic composition. A readily portable instrument, combining the functions of gamma-spectrometry and fission neutron counting, has been designed to facilitate this type of inspection and was used for much of the experimental work described here. (auth)

21297 ANALYSIS OF ACCOUNTABILITY SYSTEM IN A REPROCESSING PLANT AND A PLUTONIUM FUEL FACILITY. Nakajima, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo); Koizumi, T.; Suyama, N.; (and others). pp 139-53 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The accountability problem in a reprocessing plant and a plutonium fuel facility is described. When applying safeguards to the plant, one of the most essential data is a knowledge of the amount of MUF on a material balance. To examine and judge the reliability of the material balance, it is necessary to predict a probable value of MUF. This was done by considering the propagation of errors and the possibility of unidentified and unmeasured process losses. With this in mind, the variation in MUF was estimated by the analysis of the accountability system in the plant. Among the components of MUF, attention was paid to MUF_E which is caused by measurement errors. The material flowsheet and the operation mode were investigated to construct an accountability model. Measurement errors related to each accountability point were estimated by using available information. Then the material balance accounting was simulated by computer, assuming normally distributed random variables and a typical flowsheet. The variance of MUF_E has been derived

for two cases, i.e. for the upper and lower levels of measurement errors which reflect the methods of measurement assumed in the model. In addition to the analysis concerned with the reprocessing plant, the results of actual material accounting in the Plutonium Fuel Division of PNC are described. More than 500 kg mixed oxide of low plutonium enrichment were fabricated for a two-regioned nuclear critical experiment of heavy-water moderated and light-water cooled reactor system development. Material flows are analysed from the standpoint of systems analysis. (auth)

21298 NUCLEAR MATERIAL CONTROL IN A REPROCESSING PLANT. Srinivasan, N. (Bhabha Atomic Research Centre, Trombay, India). pp 155-66 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The provisions being incorporated in the design stage for effective material control in a fuel reprocessing plant under construction are presented. Containment and minimization of the number of material balance areas define the approach to the design. Optimization of sampling schedule and analysis is kept in mind. Reference is also made to the system of records and reports proposed for the plant. (auth)

21299 IAEA SAFEGUARDS OPERATIONS IN USA. Sharpe, B. W.; Frenzel, W.; Frittum, H.; Rubinstein, G. R. (International Atomic Energy Agency, Vienna). pp 167-79 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

A survey is made of safeguards activities on reactors, reprocessing plants and plutonium storages in the USA under two bilateral agreements; experience gained is described, conclusions are drawn and possible routes for the future are suggested. (auth)

21300 INSTRUMENTS AVAILABLE FOR SAFEGUARDING FUEL FABRICATION PLANTS. Schneider, V. W. (Alpha-Chemie und Metallurgie GmbH, Leopoldshafen, Ger.); Hille, F.; Kiy, M.; Gmelin, W. pp 181-200 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The concept of control of the flow of fissile material includes a control of the personnel and material movement into and out of the plants of the fuel cycle. The equipment required for safeguarding a plutonium fuel fabrication plant has been developed and tested. Personnel movement has been controlled successfully by means of a gamma lock for the past $1\frac{1}{2}$ years. Two safeguards experiments were carried out to prove the effectiveness of calorimetry for input and output measurements of plutonium-bearing material. A neutron measurement system is available for waste measurement. The equipment is described. The measured results communicated are subjected to a statistical analysis. (auth)

21301 MOBILE LABORATORY FOR NUCLEAR SAFEGUARDS. Menzel, J. H. (Los Alamos Scientific Lab., N. Mex.); Dennis, B. R.; Thorpe, M. M.; (and others). pp 201-21 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Los Alamos Scientific Laboratory has designed, constructed, and deployed a mobile assay laboratory to demonstrate and test the in-plant and field applications of advanced non-destructive assay techniques. These techniques include active interrogation as well as useful innovations of passive assay techniques and instrumentation. Design and performance characteristics of this Mobile Nondestructive Assay Laboratory (MONAL) are described in some detail. Initial field tests of the MONAL were conducted at Los Alamos plutonium processing plant. The first field assignment of the Mobile Nondestructive Assay Laboratory outside Los Alamos was at the plutonium fabrication facility of the Dow Chemical Company, Rocky Flats Division. These general categories of plutonium scrap in one-gallon cans and 55-gallon drums were assayed: (1) representative standards for intercomparison between MONAL non-destructive assay techniques and passive techniques presently employed by the Dow Chemical Company; (2) scrap from routine production operations where existing passive assay methods are inadequate and/or inapplicable. Field experience, system performance, and assay results are presented. (auth)

21302 TRANSPORTABLE ASSAY SYSTEM FOR SMALL AND BULK NUCLEAR MATERIALS BASED ON AN ELECTRON LINAC. Bramblett, R. L.; Ginaven, R. O.; Gozani, T.; (and others) (Gulf General Atomic Inc., San Diego, Calif.). pp 223-38 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Photoinduced reactions in the energy interval near the photoneutron thresholds and photofission barriers (5 to 10 MeV) provide a powerful means for quantitative isotopic assay for the nuclear materials contained in samples of arbitrary geometry. Because of the high intensity and energy variability of the electron accelerator which produces the bremsstrahlung photon source, a number of assay approaches may be used. These approaches include detection of (1) prompt, and (2) delayed neutrons from photofission, measurement of (3) photofission product gamma rays and the use of (4) sub-MeV neutrons or even (5) higher energy neutrons to produce characteristic reactions. Although a great variety of electron accelerators have been built, none of the commercially available accelerators have the qualifications of smallness, shielding, and economy that are necessary for this application. Consequently, a small linear electron accelerator (LINAC) has been designed and built for this application using proven engineering concepts. The LINAC has been incorporated into a transportable assay system which also includes neutron and gamma-ray detector systems, a scanner for bulk samples, and an on-line computer for data accumulation, control of measurement apparatus, and analysis of assay data. The unique advantages of nondestructive assays exist for the case of inhomogeneous samples, such as barrels of nuclear scrap. For these samples, it is impossible or very difficult to obtain a representative small sample for destructive analysis. If the entire sample can be interrogated in such a way as to produce uniform response from all the nuclear material present, the sampling problem can be avoided. The bulk sample assay technique being developed at Gulf General Atomic involves detection of prompt and delayed neutrons produced by irradiating the sample with a bremsstrahlung beam produced by electrons from the LINAC operating at energies between 6 and 10 MeV. In the lower portion of this energy range, prompt neutrons are produced in only a few materials including isotopes of plutonium, uranium and thorium, while over the whole energy range delayed neutrons provide a unique indication of the presence of fissionable material. Correction for attenuation of the incident bremsstrahlung and the emergent neutrons is made possible by the use of a collimated beam to scan the sample while it is rotating. Neutrons are detected on both sides of the sample by BF_3 neutron detectors in hydrogeneous moderator. The neutron yield on each side is recorded as a function of the displacement of the center of the sample from the beam center. The attenuation of the interrogating beam is measured and the neutron attenuation is determined from the difference in the number of neutrons counted on the different sides of the barrel when it is off center. The neutron yield at each sample displacement is corrected for both attenuations in order to obtain uniform sensitivity to nuclear material no matter where it is located within the container. The application of this system to certain types of scrap (e.g., uranium with various matrix materials and plutonium contaminated ash) is discussed along with methods of accounting for attenuation of the interrogating beam and the emerging neutrons. (auth)

21303 POSSIBILITIES OF DETERMINING THE THERMAL OUTPUT OF A POWER REACTOR ON THE BASIS OF MEASUREMENTS OF THE ELECTRICAL OUTPUT. Drahny, M.; Kucera, J.; Svetlik, J. (Power Research Inst., Prague). pp 239-49 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The problems of determining the thermal output of a reactor on the basis of the measured electrical output are discussed. The possibilities of measuring the electrical output are analyzed and the optimum points for measurement, the measurement method and instrumentation are established. The relationship between thermal and electrical output components is studied and the obtainable accuracy of results is estimated and discussed. It was concluded that this method can be recommended as a simple checking method for safeguards purposes. (auth)

21304 EVALUATION OF THE EFFICIENCY OF SAFEGUARD MEASURES FOR FABRICATION PLANTS AND REACTORS. Beets, C. (CEEN, Brussels); Goossens, H.; Mostin, N. pp 251-70 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970). (In French).

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From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Safeguard measures were considered for application in the BR2 fuel cycle (fuel fabrication and reactor) on the one hand, and in a projected plutonium-enriched fuel fabrication plant, on the other hand. The BR2 reactor is characterized by a yearly throughput of some 50 kg of highly enriched uranium alloy (90% of ^{235}U), while the plutonium facility has a designed throughput of 25 kg a day of UO_2-PuO_2 at 25% fissile material. For each of the above facilities, a diagram of the steady-state flow of fissile materials in the course of operation was first established and this in turn was converted into a so-called mathematical model, by means of a suitable symbolic representation. The latter was then extended so as to embody several diversion routes and inspection procedures. Besides, detection techniques, such as gamma spectrometry and neutron beam interrogation were tested and analyzed for their response to fissile material contents of both component plates and assemblies. By treating a few simple cases selected from the BR2 fuel cycle, it was possible to provide an estimate of the efficiency of the control for various levels of action. (auth)

21305 DESIGN OF A SAFEGUARDS MATERIAL CONTROL SYSTEM. Brown, F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 273-87 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The requirements of an inspector for the application of safeguards to a complete fuel cycle or an individual facility are reviewed. Particular attention is paid to the desirability of maintaining well-defined material balance areas and of determining key points in the fuel cycle where inspection would be meaningful, i.e., where a measurement of quantity, isotopic enrichment, etc. would be possible. Use of information derived from key point measurements, together with accounting data in respect of material balance areas, should enable control to be exercised without detailed inspection of other parts of the plant. The design of the accounting system to be used, and of the associated records and report, is reviewed. The amount of information, which has necessarily to be transmitted, is discussed, and various criteria for determining this are examined. Reference is made to the desirability of laying down design criteria which will facilitate the application of safeguards, but this topic is not examined in detail as it forms the subject of a separate paper being presented to the Symposium by the United Kingdom. (auth)

21306 INITIAL STEPS IN THE ESTABLISHMENT OF A NATIONAL MATERIALS ACCOUNTABILITY SYSTEM. Lendvai, O. (Hungarian National Atomic Energy Commission, Budapest). pp 289-303 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Until last year no centralized nuclear materials control system existed in Hungary. Such materials, with the exception of reactor fuel, were accounted for on the same basis as other radioactive substances. In connection with the ratification of the NPT, work has been initiated to establish a national control system for nuclear materials. The organizational set-up for the establishment of an initial inventory and for subsequent routine accountability operations is described, including evaluation of the initial and running workload and expenses. The existing operative nuclear materials management was adapted to the requirements of a national safeguards system. Some generalizations are made with regard to states not possessing a closed nuclear fuel cycle. (auth)

21307 NUCLEAR MATERIALS ACCOUNTABILITY SYSTEM FOR CANADA TO MEET REQUIREMENTS OF THE NPT. Rose, H. A. (Atomic Energy Control Board of Canada, Ottawa). pp 305-25 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

At the time that Canada ratified the NPT the nuclear materials accountability system in use was not compatible with verification by international inspectors. Since the NPT requires that a national system of accounting for nuclear materials be in effect, the task of modifying the Canadian system was undertaken early in 1969 by the safeguards group of the Atomic Energy Control Board of Canada. The system that has been proposed and is under consideration by both government and industry at the present time is described. The system consists of three main operational divisions: reporting of transfers of nuclear materials and periodic status or inventory reports, which are submitted to the Board, compilation of ledgers for all users of nuclear materials in Canada and filing of such reports and ledgers, and inspections to verify inventories at the various locations. A standard materials transfer report form is described. This form will be submitted by both shipper and receiver for each transfer of uranium, thorium, plutonium or heavy water. The form has been designed to make conversion to machine accounting possible at a later date. An RIS (reporting identification symbol) directory for Canada and the materials classification codes used are also described. The system of ledgers being implemented by the Board is described as well as a filing system which segregates accountability material which would be open to IAEA inspectors from confidential national files. Verification inspection procedure is considered to be outside the scope of this paper. (auth)

21308 EXPERIENCE OF THE OPERATION OF A MATERIALS CONTROL SYSTEM. FREQUENCY OF SUBMISSION AND USEFULNESS OF OPERATIONAL REPORTS AND SUMMARY REPORTS. Billy, G.; Lecomte, F. (CEA, Paris). pp 327-37 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970). (In French).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The following problems are discussed: management of basic nuclear materials in France-privileged position of the CEA; example of control in a particular plant (external movements-quantitative or qualitative discrepancies; internal movements, accountability areas, key points, sampling, measurements, workshop cards and comparison of actual inventory with workshop cards); materials accounting of the plant (operational account); description, movement, output; comparison of actual inventory with materials accounting results; centralized physical accounting with description of the system; and relationship between operational accounts and the centralized accounting system; and study of an accounting system for safeguards purposes which includes general principles governing definition of information required, standardization of accounts and summary reports, frequency of submission, and usefulness of summary reports. (auth)

21309 TECHNICAL FEASIBILITY OF APPLYING THE SAFEGUARDS SYSTEM TO ATOMIC POWER STATIONS USING WATER-COOLED AND MODERATED POWER REACTORS. Skvortsov, S. A.; Miller, O. A. (Inst. of Atomic Energy, Moscow). pp 339-44 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970). (In Russian).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The feasibility of applying the IAEA safeguards system to water-cooled and moderated power reactors is demonstrated. They analyze the specific features of these reactors of importance in safeguards, and consider the basic tenets involved in implementing the safeguards, namely systems for accounting for nuclear materials and following their movement through the station. Recommendations are given on methods of keeping account of nuclear materials and spot checking on their accumulation, and suggestions are made for checkpoints. Possible ways of assessing the effectiveness of the safeguards, of the requisite accounting documents, and of techniques and procedures for inspecting atomic power stations using water-cooled and moderated power reactors are discussed. (auth)

21310 EFFECTIVE APPLICATION OF SAFEGUARDS MANPOWER AND OTHER TECHNIQUES IN NUCLEAR FUEL CYCLES. Avenhaus, R.; Gupta, D. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). pp 345-73 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

One of the important areas in the field of safeguards application is the development of criteria for the optimum application of safeguards efforts. An effort is made to define and develop such criteria from the point of view of a safeguards organization. The reference fuel cycle consists of conversion, fabrication and reprocessing facilities, light-water reactors and a Pu storage. A complete flow and process inventory of fissile materials in all these facilities has been given as the input data. Various safeguards plans for the application of inspection personnel and use of various safeguards measures have been worked out for such a fuel cycle. The corresponding standard deviations in the establishment of the total material balance have then been worked out after introducing a number of factors like effective kilograms, asses-

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sibilities of the fissile material, etc. These weighted effective standard deviations were taken as the criterion against which the effectiveness of the different safeguards plans are compared and analyzed. The model developed is explained with the help of a numerical example. (auth)

21311 DYNAMIC SAFEGUARDS SYSTEM FOR MULTIPLE ACTION LEVELS. Oshima, K. (Tokyo Univ.); Imai, R.; Nakajima, N.; Watanabe, S. pp 375-88 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Simulation models for low-enriched uranium and plutonium cycles have been constructed for assumed 1975 nuclear activities. A dynamic safeguards system is applied to the quantified models in order to establish different action levels for inspecting authority. Computerized data collection is considered from various strategic points of the materials flow in the model. Strategic points are designed and measurements scheduled in such fashion as to calculate EMUF and its deviation for different confidence levels. Depending on the differing levels of verification, the international safeguarding authority may determine different levels of actual inventory taking. (auth)

21312 CRITERIA FOR THE DESIGN OF NUCLEAR INSTALLATIONS TO FACILITATE THE APPLICATION OF SAFEGUARDS. Brown, F. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Coles, R. F.; Ellingsen, J. E.; (and others). pp 389-94 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The application of safeguards will necessitate that inspection requirements be considered as an essential item at the initial design stage of all future nuclear facilities. An inspectorate must rely on a combination of accountancy, containment and surveillance, and the aim of any design criteria will be to make the application of these concepts as simple and as efficient as possible. However, the detailed design will depend on the nature of a particular facility and on the inspection procedures envisaged. Various types of nuclear facility are considered both in isolation and as part of an integral fuel cycle to indicate in principle what the balance of inspection requirements might be and to show how the normal principles of plant design might need modification and/or extension to meet such requirements. The points of safeguards importance in a typical fuel cycle are identified and available measuring techniques are indicated. In many instances all that is required is an extension of normal design principles but certain additional concepts will have to be applied, such as the tamper-proof sealing of containers, the bonding of stores, dissolvers etc., and the monitoring of fuel movements (e.g., charge/discharge machine monitors at reactors). Plant layout is influenced by the need to provide easy access by inspectors to storage and measurement facilities. The design and layout of measurement facilities is likely to be complicated by the essential requirement that an inspector must be able to verify readily the calibration of tank volumes, weighing devices and nondestructive measurement instruments. The definition and value of field trials and integral experiments are discussed and the difficulties in attempting to carry out such trials and experiments at existing plants which were not designed with inspection in mind are defined. Any attempt to modify existing plants to conform to the proposed design criteria would be prohibitively expensive and lead to the complete disruption of economic operations. However, such plants may be expected to come under safeguards and a practical appreciation of the difficulties of inspection will be of value both to inspectorate and management. (auth)

21313 PLANT INSTRUMENTATION AND ITS RELATION TO THE DESIGN OF SAFEGUARDS MATERIALS CONTROL SYSTEMS. Bartels, W. C. (Atomic Energy Commission, Washington, D. C.); Higinbotham, W. A. pp 395-403 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Materials accounting organizes quantitative information obtained by plant operators and inspectors. A materials control system uses this information with emphasis on the evaluation of materials unaccounted for (MUF). Reliable and precise quantitative information usually is obtained by chemical analysis of materials samples. Materials sampling is a costly method of assaying reactor fuel assemblies and often an inaccurate method of assaying heterogeneous process scrap and waste solids. Chemical analysis of inspectors' samples often requires the most elapsed time in a verification of the presence of a stated inventory of nuclear materials. Various nondestructive assay methods have been demonstrated and experience has been presented on use of such methods in operational materials control systems. They can supplement and largely supplant chemical assay techniques for assay of reactor fuel and many heterogeneous materials. They can be used to make measurements on inventory components otherwise inferred indirectly as equal to the difference between measured inventory, feed or product components. They can be used for timely assay of inspectors' samples during inventory verification. The United States Atomic Energy Commission recently began a Plant Instrumentation Program to accelerate the application of nondestructive assay measurements in materials control systems of the nuclear power fuel cycle. The initial phase of the effort involves private plutonium fuel fabrication facilities and facilities for processing highly enriched uranium scrap. The reasons for this selection relate both to nuclear weapons technology and to the projected increasing use of plutonium within the nuclear power industry, and the heterogeneous nature of most highly enriched uranium scrap. The Program began several months ago. Experience with the nondestructive assay methods should provide an improved basis for design of materials control systems for fuel fabrication facilities. Future undertakings being considered include chemical processing plants for spent fuel from nuclear power plants, the power plants and uranium enrichment facilities. (auth)

21314 CONTROL OF FISSILE MATERIAL FLOW IN HIGH-TEMPERATURE PEBBLE-BED REACTORS. Bedenig, D. (Brown Boveri/Krupp Reaktorbau GmbH, Juelich, Ger.); Rausch, W.; Schulten, R. pp 405-19 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

In any plant producing goods from rather valuable raw material or pre-products the flow of material and the associated flow of costs have to be monitored closely to obtain economically optimum results. This holds especially for energy-producing nuclear plants, the costs per unit of weight of fissile material being roughly ten times that of gold. Conditions for the control of fissile flow are extremely favorable in pebble-bed reactors which differ in several aspects from most other reactors: e.g., the subdivision of the fuel inventory into a very great number of individual fuel elements of the order of 10^6; the continuous circulation of fuel elements allowing within certain limits any wanted degree of burn-up for the fuel elements to be obtained; and the possibility to measure the fissile content of each individual fuel element with high accuracy. These possibilities must be compared to the requirements of an economically optimum management of the fuel inventory which include: optimum burn-up should be obtained for each individual fuel element; optimum core configurations should be obtained by directing the flow of fissile material accordingly; and diversion of fissile material should be detected. With the Thorium High Temperature Reactor (THTR) burn-up is monitored by the fissile content of fuel elements. Due to conversion of thorium the fissile content of fuel elements changes rather slowly. This leads to the strongest requirements for accuracy of fissile detection. Requirements for the control of integral flow of fissile material for optimum core configurations or detection of diversion are much easier fulfilled as the relative integral accuracy over a great number of elements increases with the number of elements measured individually. Comparing the THTR accuracy requirements for optimum fuel management with those for safeguarding fissile material, accuracy requirements for safeguards appear considerably lower. On the other hand, it is the decision of the plant operator to take the cost penalty for running the plant for a limited time without close control of fissile flow in the event of a failure in the monitoring system, whereas for safeguards continuous performance should be secured by all means possible. (auth)

21315 VERIFICATION OF NUCLEAR MATERIALS. Hough, C. G.; Solem, L. C. (International Atomic Energy Agency, Vienna). pp 421-31 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The direction of the technical development of principles and procedures for the verification of nuclear materials is summarized. The safeguards system of the IAEA is briefly described and verification of nuclear materials is defined as the decision process or structure whereby the quantities and locations of nuclear materials can be established by the application of the safeguards measures; material balance accountancy, containment and surveillance. The decision process is presented in four stages. The first is the use of records and reports, the second is verifica-

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tion by independent measurements, the third is evaluation of significant unaccountability of nuclear material, and the fourth is use of containment and surveillance as safeguards measures. (auth)

21316 US SAFEGUARDS EXPERIENCE IN REGULATION AND INSPECTION OF THE PRIVATE NUCLEAR INDUSTRY. Wischow, R. P.; D'Amico, V. J.; Page, R. G.; Ong, L. D. Y. (Atomic Energy Commission, Washington, D. C.). pp 435-49 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The Division of Nuclear Materials Safeguards is responsible for implementing the USAEC domestic safeguards program for the private nuclear industry. Specific safeguards requirements have been applied through the Commission's regulatory process and inspection program has been implemented to ensure that an effective materials control system is maintained. Experience has underlined the importance of understanding the type, quantity and quality of measurements that are necessary for a facility to adequately establish and evaluate the significance of the amount of special nuclear material unaccounted for (MUF). Of special interest has been the applicability of the parameters MUF and the limits of error of MUF as safeguards indicators of the effectiveness of facility material control systems. The unacceptability of all "by-difference" measurements and book accounting adjustments that would improperly reflect the material balance is emphasized. Inspection efforts have particularly concentrated on auditing records and performing independent measurements, using both destructive and nondestructive methods, of facility inventory material selected by random sampling plans. Duplicate sampling of apparently non-homogeneous material is also discussed, leading to estimates of the magnitudes of limits of error for certain material types. (auth)

21317 ANALYSIS OF COMPONENTS OF MATERIAL UNACCOUNTED FOR. Gmelin, W.; Kraemer, R. (Kernforschungszentrum, Karlsruhe, Ger.). pp 451-71 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Material unaccounted for (MUF) is defined as the numerical result of a material balance. In the expectation of MUF, i.e., EMUF, the random error components of the measurements are not included and EMUF is analyzed. The different components of EMUF are described or defined for diversion-free situations, namely the systematic errors of the measurements, the losses by plate-out effects, the losses by maloperation, etc. The emphasis of the theoretical analysis lies on the investigation of the propagation of the systematic errors and the plate-out effects. For these two components statistical methods for their detection based on paired comparison and correlation techniques are described. Additionally, the principle and the theory of specially designed experiments are evaluated, e.g., the so-called mix-batch experiment, whose theoretical analysis and results can lead to an understanding of the systematic errors. An investigation of the experimental results obtained so far with respect to the MUF problem is described. The results of the two integral exercises in the reprocessing plant EUROCHEMIC at Mol and of the two ALKEM exercises are investigated. The existence of systematic errors between the measurements of the operator and the experimental analyses could be detected in case of the Mol exercises as well as for the different input measurements at the ALKEM exercises and possible reasons for these errors could be evaluated. The numerical results of all these analyses show that in case of the exercises these systematic errors of the measurements are the main components of MUF. (auth)

21318 STUDY OF THE MUF VALUES CALCULATED DAILY OVER THREE BALANCE AREAS DURING A REPROCESSING RUN FOR HIGHLY ENRICHED URANIUM FUEL. Moeken, H. H. Ph.; Franssen, F.; Beckers, J. (EUROCHEMIC, Mol, Belg.). pp 473-87 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

A safeguards system for a reprocessing plant, using available volume and density measurements on the process vessels and available laboratory measurements carried out for process control reasons, is described and its application during a short reprocessing run for highly enriched uranium fuel given. The potential effectiveness of the system is high because it is capable of locating an apparent diversion and reducing the time during which the diversion can remain undetected. The indicators of the control system are the MUF values calculated daily over three balance areas: the head-end, the first extraction cycle and the second extraction cycle. The observed MUF and inventory values are presented. The error sources affecting the measurements on which the system is based are investigated by comparing pairs of values of the same variable measured in two different ways. The spread of the MUF values is not explained by the measurement errors. The fluctuations in the unmeasured process inventory and other operational effects contribute considerably. (auth)

21319 ANALYTICAL CONTROL OF FISSIONABLE MATERIALS: RECEPTION CHECKS AND INTER-LABORATORY COMPARISON EXCHANGES. Artaud, J.; Huart, A. (CEN, Grenoble, France). pp 489-508 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970). (In French).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The Department of Chemistry of the Commissariat à l'Énergie Atomique (Sections for Chemical and Analytical Studies) is concerned under various heads with the analytical control of fissionable materials and the related management problems. Two principal aspects of this control are described. The Central Laboratory for Analysis and Control at Grenoble (Analysis and Applied Chemistry Section) specializes in reception checks (qualitative and quantitative) in respect of commercial transactions on a national and international basis. A number of results from such checks are given and the reasons for certain inter-laboratory discrepancies studied. The results obtained in one particular case are analyzed in greater detail. For purely French laboratories (CEA and nuclear industry) a regular check on the results is maintained by means of inter-laboratory comparison exchanges. These exchanges are a means of arriving at a better knowledge of the potential capacity of individual laboratories and a better interpretation of the analytical results. Special emphasis is placed on the sampling criteria for such exchanges depending on the particular information it is desired to obtain (reproducibility, accuracy, calibration, etc.). Some results are given from isotopic analysis comparisons of uranium and plutonium. (auth)

21320 COMPUTERIZED MATERIALS ACCOUNTING SYSTEM AT TOKAI POWER STATION. Imai, R.; Takaya, K. (Japan Atomic Power Co., Tokyo). pp 509-17 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The Tokai Nuclear Station is a 149-MW(e) Magnox continuous-refueling power reactor. A computerized materials accounting system has been developed and in use ever since fuel was loaded into the core (2.048 channels × 8 elements). The program has two functions, namely of tracing the in-core and discharge history of individual fuel elements, and of assigning cumulative burn-up and plutonium production based on the assumed power distribution to each fuel element. The program itself and practical experience from which readers can appreciate the unexpected MUF arising from S/R differences, burn-up code improvements, flux shape measurements, etc., are described. (auth)

21321 SOME CORRELATIONS BETWEEN ISOTOPES OF Xe, Kr, U, Pu, AND BURN-UP PARAMETERS FOR VARIOUS THERMAL AND FAST REACTORS. Koch, L.; Braun, H.; Cricchio, A. (EURATOM, Karlsruhe, Ger.). pp 539-44 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Various fuel samples originating from different thermal and fast reactors have been analyzed in the past. Using the isotope dilution technique, isotopic concentration of heavy elements (uranium-232, 234, 235, 236, 238, neptunium-237, plutonium-236, 238, 239, 240, 241, 242, americium-241, 242, 243, curium-242, 244), retained fission krypton and xenon, and neodymium (burn-up determination by ^{148}Nd) were determined. The samples were derived from two BWRs, one PWR, two heavy-water moderated reactors, two fast reactors and from test fuels irradiated in different reactors. To check the consistency of post-irradiation analysis results, correlations between the isotope concentrations themselves and some reactor parameters (total and fractional burn-up, fission source ratio, conversion, etc.) were established. These correlations can be used in identifying reactor fuels (fingerprint analysis) and to esse the input analysis at the reprocessing plant, e.g., the isotopic rstios of Kr and Xe can be correlated with good accuracy to the

burnup and Pu production. In this case the sampling of the fission gas need not be quantitative and can be done on the exhaust gases without entering the plant. Some propositions are made to ease the sampling of the dissolver solution and to avoid radiolytic effects during storage. (auth)

21322 NON-DESTRUCTIVE BURN-UP DETERMINATION BY 145-keV GAMMA-RAY ABSORPTION. Kreyger, P. J. (EURATOM, Petten, Netherlands); Harry, R. J. S.; Kroeckel, H. pp 545-50 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

A gamma-ray absorption method for nondestructive uranium determination in irradiated and unirradiated MTR-type fuel elements is described. The method is essentially a comparative measurement of the 145-keV gamma-ray absorptions in the element under test and a reference element. The gamma source is provided by a briefly cooled irradiated fuel element, containing the 32.5-d half-life 145-keV gamma emitter ^{141}Ce as fission product. The intensities of the gamma rays passing through the test element and a collimator are measured by means of a Ge(Li) detector, the signals of which are analyzed by a multichannel analyzer. Burnup is derived from the 145-keV intensities by a relationship which requires a knowledge of some geometrical parameters of the fuel elements and the gamma-ray absorption coefficients of uranium, aluminium, water and uranium fission products at 145 keV. Burnup distributions and total burnup values are obtained by mechanical scanning of elements. Measurements applied to the 90% enriched uranium MTR-type elements of the High Flux Reactor at Petten carried out in an experimental installation in the reactor storage pool permitting underwater tests are described. Results are compared with fuel management burnup calculations, measurements in air and isotope composition analysis (destructive determination) results. The precision of the method and its improvement are discussed. (auth)

21323 SOME DEVELOPMENTS IN INPUT ACCOUNTABILITY AT EUROCHEMIC. Moeken, H. H. Ph.; Bokelund, H. (EUROCHEMIC, Mol, Belg.). pp 551-62 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

The input of nuclear materials to the reprocessing plant is established by the determination of the amounts of these materials present in the batches of dissolved fuel contained in the assessment vessel. Experience with the volumetric and the gravimetric assessment methods is reviewed. An improvement of the standard volumetric method applied at EUROCHEMIC and the obtained precision are discussed. The manometer readings on the assessment vessel for volume measurement and the results of the laboratory determinations are checked routinely by means of verification procedures. The application of these procedures is described. (auth)

21324 SUMMARY OF RESULTS OBTAINED FROM THE FIRST MIST EXPERIMENT AT NUCLEAR FUEL SERVICES, WEST VALLEY, NEW YORK. Christensen, D. E. (Battelle-Northwest, Richland, Wash.); Ewing, R. A.; Gaines, E. P. Jr.; (and others). pp 563-82 of Safeguards Techniques. Vol. I. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.1); CONF-700701-(Vol.1).

Several potential, independent safeguard methods, collectively known as Minor Isotopes Safeguard Techniques (MIST), were experimentally tested during the chemical reprocessing of nuclear fuel from Yankee cores V and VI at the Nuclear Fuel Services (NFS) plant. The mass spectrometric data on uranium and plutonium obtained by NFS on each input and product batch has been compared with analyses of duplicate samples made by the National Bureau of Standards. In general the NFS data has been found to be suitable for most MIST applications. In addition, linear relationships between the isotopes of uranium and plutonium have been found that permit recognition of small analytical errors in the measurement. Careful batching of Yankee fuel elements from cores V and VI having similar exposure histories has also permitted detailed tests of the method of estimating the plutonium content of dissolver solutions using a ^{235}U isotopic depletion relationship. The data obtained from this experiment, combined with the available data on the earlier Yankee campaigns, suggests that for different enrichments as well as exposures the grams of Pu/tonne U can be estimated to approximately 1%. The careful batching of the fuel has also aided in: the establishment of a number of useful empirical isotopic correlations between the uranium and plutonium in the fuel: the possible improvement of current reactor cross-sections and codes and the development of a basis for the isotopic recognition or "fingerprinting" of Yankee fuel. Digital simulation of the NFS plant indicated, prior to the commencement of the Yankee campaign, that the proposed sequence of batches of fuel from cores V and VI would preclude the determination of an inprocess plutonium inventory using minor isotope techniques. However, after verification of the NFS digital model on the actual Yankee campaign, a simulated campaign was run in which the calculated distribution of input batch fractions in the output batches was determined to within approximately 5%. In addition, the digital model, in itself, appears to have potential as a useful safeguards tool. For example, the model may be used both to verify overall plant operations and to assess theoretically certain possible methods of diversion. (auth)

21325 SUMMARY OF UNITED STATES QUALITATIVE SAFEGUARDS TECHNIQUES. Sastre, C. (Brookhaven National Lab., Upton, N. Y.). pp 197-204 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

Some of the immediate goals of all safeguards techniques are timely detection, proof of diversion, diverter identification, recovery and impeding of diversion. Qualitative safeguards techniques include methods of achieving these goals which can be used to supplement quantitative techniques, especially where the latter are hindered by difficulties of measurement. The present state of the art in the field of qualitative safeguards techniques in the US is reviewed, with emphasis on suitability of available equipment to attain the goals. Satisfactory qualitative safeguards techniques are not available in a fully developed form for direct adaptation to the particular conditions encountered in some parts of the nuclear industry and as a result original development or adaptation is indicated for these applications. These needs will be identified and discussed. (auth)

21326 CONTROL OF FUEL ELEMENTS IN THE CONTEXT OF INTERNATIONAL SAFEGUARDS. Brown, F. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Buckley, G.; Ellingsen, J. E.; (and others). pp 205-13 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

During manufacture fuel elements are usually sequentially numbered for quality control and other operational reasons. Subsequently these serial numbers can be used, in principle, for safeguards control purposes. However, before this can be done, it is necessary for there to be at least one of two possible additional attributes: either the fuel elements must remain in some form of containment throughout the remainder of the fuel cycle, or the serial numbering must be associated in each case with a unique, tamper-proof characteristic—the mere use of an etched or engraved number or code is insufficient. The containment alternative will rely on the application of containment, surveillance and nondestructive measurement techniques to the flow of fuel elements from the fabrication plant, through the reactor, into irradiated fuel storage facilities and finally to reprocessing plants where the fuel will be dissolved and the fissile material therein measured. Basically, the system depends on bonded stores, sealed transit containers, nondestructive measurement of the unirradiated fuel, movement monitors at the reactor and storage facility, and a bonded dissolver at the reprocessing plant. An important part of this system is the monitoring of movements of irradiated fuel in an on-load refueling reactor. In 1966 the UKAEA carried out a feasibility study for the IAEA on the possibilities of designing a simple device for this purpose. Subsequently it was decided that further work should be carried out on this subject up to the development of a prototype instrument. The instrument has been successfully used on the Advanced Gas-cooled Reactor at Windscale and is currently being installed for further trials on a Magnox reactor at Bradwell. The general principles of this instrument and some details of the problems involved are described. The alternative to the containment of the fuel throughout the fuel cycle is the use of some technique whereby the number placed on the fuel element for manufacturing purposes can be uniquely related to some characteristic which is tamper-proof, such as a photograph of the structure of a major weld. The only advantage of such a system of unique identification appears to lie in the field of accountancy by single quanta (i.e., single fuel elements or assemblies). Suitable techniques can be devised, but, in a large power program the cost to both operator and inspector needs careful assessment. This applies even when the fuel is in the form of relatively few large assemblies; where large numbers

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of small elements are involved, the technical problems of verifying the identification of each element, and the consequential costs, will be greatly increased. (auth)

21327 METHODS OF TAMPER-PROOF IDENTIFICATION FOR USE IN SAFEGUARDING THE FLOW OF FISSIONABLE MATERIALS BY THE CONTAINMENT TECHNIQUE. Jehenson, P. S.; Crutzen, S. J.; Borloo, E. E.; Jansen, J. C. (EURATOM-CCR, Ispra, Italy). pp 215-29 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970). (In French).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

The flow of fissionable materials through the fuel cycle from the fabrication of fuel elements to reprocessing can be safeguarded in a tamper-proof manner by the containment technique, applied partially or fully. In 1969 various methods of identification and of reidentifying the markings and verifying the identity of the materials were studied. The main results obtained in applying to MTR fuel plates a patented method of ultrasonic identification of special markings are presented. The markings were produced by a random and non-reproducible dispersion of or inclusions of suitable shape and size at a particular point on the MTR fuel plate. The results of current work on seals are discussed. The method used in the identification marking of seals is similar to that employed with the MTR fuel plates. Several methods of verification were studied. Some types of seals are described. With the containment technique, verification can be centralized and data tamper-proof identification markings can be processed in a single place. (auth)

21328 PROGRESS REPORT ON THE DEVELOPMENT OF A TAMPER-RESISTANT SAFING SYSTEM FOR INTERNATIONAL SAFEGUARDS AND ARMS CONTROL APPLICATIONS. Hogan, R. G. (Corning Glass Works, N. Y.); Stieff, L. R. pp 231-43 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

The problem of the design and construction of a secure safing system has been of concern to the Arms Control and Disarmament Agency for a number of years because of the direct role that such devices would play in the process of implementing and verifying certain international arms control or safeguards agreements. The International Atomic Energy Agency is currently using a seal developed for the US Internal Revenue Service when applicable. This seal is simple, inexpensive, and relatively secure but it does not permit field identification or a field continuity check. A simple design has been made using Corning Code 5010 flexible glass fibre optic bundles. This product consists of a 225 unit fibre bundle with the individual fibres 0.0025 in. (nominal) in diameter. Process techniques provide a random cross-sectional fibre configuration. Statistical analysis has shown that 97% of the time at the 95% confidence level a unique fingerprint occurs. The fiber bundle will be protected by a clear polyvinyl-chloride sheathing and can be prepared in continuous lengths up to 25,000 feet. One end of the fiber bundle will be permanently fastened in a small (1 in. × 1 in. × $^1/_4$ in.) CHEMCOR brand block of clear, chemically strengthened glass (Code 0313). The other end of the fibre bundle will be permanently fastened in a small diameter glass tube. Optical polishing of the fiber ends and a photograph of the fingerprint will be completed in the factory. After simple field assembly, involving essentially a snap lock, all that is required to verify the integrity of the seal is a small camera, a light source and the negative of the factory obtained fingerprint. Any attempt to pull one end of the fiber bundle from the CHEMCOR block will either cause the block to fracture or will pull a spring clip through the bundle which will destroy the unique fingerprint. Any attempt to cut through the bundle and then reseal will also destroy the unique fingerprint. (auth)

21329 PROGRESS IN SYSTEMS ANALYSIS. Bennett, C. A. (Battelle-Northwest, Richland, Wash.). pp 247-54 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

The past decade has seen substantial progress toward the application of systems analysis to the problem of safeguarding nuclear materials. This work can be categorized broadly into three areas: the definition and characterization of the system to be studied; the development of means for evaluating the effectiveness of alternate systems; and the definition of objectives and the formulation of quantitative criteria for measuring their achievement. The most significant advances during this time have been in the definition of the system to be studied and in the development of statistical techniques and mathematical models for the measurement of effectiveness and evaluation of alternate safeguards procedures. Progress in the last of these three areas has been less rapid, but in the past several years there have been several significant contributions in this area which should stimulate rapid future advancement. Recent years have also seen a growing awareness of the difference in objectives between facility, national, and international safeguards systems. This recognition of gradations in emphasis has had a corresponding effect in broadening the methodology used to measure effectiveness. (auth)

21330 VARIOUS ASPECTS OF SYSTEMS ANALYSIS. Gupta, D. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). pp 255-64 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

A review of the systems analytical investigations in connection with safeguards being carried out at a number of places indicates that they can be considered from the following six aspects: collection and classification of information; understanding and interpretation of reality; reduction and limitation in the uncertainty of knowledge in the "space-time-amount" plane; quantification of terms and relations; effectiveness of the whole safeguards system; formulation of actions and action levels. Basically the safeguards system requires consideration of three parameters, namely the fissile materials, the facilities in which they are processed and the interests of the operators of these facilities and the safeguards measures imposed on these materials to detect whether any diversion has taken place. The operators of these facilities handle, process and use these materials for commercial and research purposes, whereas the safeguards system deals with the information generated at the different steps. It is desirable and also sufficient to obtain and base the safeguards measures on the hard core of information only. The use and processing of fissionable materials in nuclear facilities give rise to limitations and problems which cannot be found or solved to the fullest extent by theoretical considerations alone. Integral experiments in facilities under well-defined conditions, interlaboratory tests and design of plant layouts in collaboration with the designers and operators of nuclear facilities are required for this purpose. There is always a finite amount of uncertainty in knowledge in the time, location and amount with regard to a diversion. Major efforts are required to keep the total uncertainty within some acceptable and practicable limit. A variety of terms and relations in safeguards require quantification so that they can be defined and used objectively. Particularly important in this connection is the relation between the operators interests and the objectives of a safeguards system. The use of games theory appears to be useful for quantifying this relation. A major part of the safeguards effort is oriented towards defining the effectiveness of a system and devising and developing means of reducing the efforts without reducing significantly the effectiveness of the system. Finally, one of the important aspects of systems analysis is the formulation of procedures for the execution of safeguards measures and for different safeguards action levels. (auth)

21331 USEFULNESS OF SYSTEMS ANALYSIS. Morgan, F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 265-83 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

Systems design necessarily includes a theoretical analysis of the factors involved, to indicate their relative importance and possible consequences. This leads to practical tests of a partial or integral nature to ensure that no important factors have been omitted and that the design as a whole is understood. Systems analysis then may be used to suggest appropriate executive action, e.g., the optimum allocation of resources to development or inspection. The same factors are also important in assessing in an objective way the significance of observations made. However, difficulties may arise here because, for example, the system may in practice not be "in control" in the sense that the detail of nuclear activities is changing constantly for operational reasons; too mechanical a use of statistical significance tests may be counter-productive unless other relevant facts are considered. The scope for systems analysis is surveyed, considerations which may limit the validity and usefulness of theoretical models are suggested, these are illustrated with numerical examples. (auth)

21332 ASSESSMENT OF MATERIAL UNACCOUNTED FOR CONTROL CRITERIA. Rowen, J. W.; Murphey, W. M.; Smith,

C. N. (National Bureau of Standards, Washington, D. C.). pp 291-310 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

Some of the factors that affect the usefulness of Material Unaccounted For (MUF) control criteria include process activity, measurement errors, normalization factors, time frame, inventory fluctuations and unidentified process losses. It is important to know whether and how such criteria vary with the character of the data source and with variations in facility situations. MUF criteria corresponding to three types of data sources and two situations are theoretically analyzed. The two situations differ in that measurement errors are known in one but unknown in the other. Quantitative criterion expressions are developed for the six possible conditions of evaluation resulting from the three types of data sources and the two measurement situations. The statistical expressions developed are compared with each other and some available data are presented. Tentative conclusions are drawn with respect to the comparative sensitivities of the criteria resulting from the six possibilities. These conclusions will be tested in the US Atomic Energy Commission's integrated safeguards experiments. These experiments which will provide data for some of the situations will involve subprocess, batch and campaign balances in which information on measurement errors will be available. (auth)

21333 APPLICATION OF DIGITAL SIMULATION TECHNIQUES FOR PROCESS INVENTORY ESTIMATION. Drosselmeyer, E. (Kernforschungszentrum, Karlsruhe, Ger.); Kraemer, R.; Rota, A. pp 311-31 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

Simulation plays an important role in the estimation of the process inventory of fissile material in a reprocessing plant. There are two objectives: to determine the signal deformation by various mixing mechanisms taking place in the plant; and to indicate the limiting conditions for the application of process inventory determination by isotope analysis. The complete flow and the important mixing mechanisms in the EUOCHEMIC plant were simulated and the results of this simulation compared with those obtained during the EUROCHEMIC II experiment. In addition, further simulation work on the flow of Pu in another campaign is described. For both purposes the following main mixing mechanisms are considered: linear mixing in batchwise-operated units; typical mixing in a buffer tank (which can be described by a linear differential equation); and integrating units, such as a product tank. The influence of variation in the essential parameters on the overall response function of the simulated plant was studied by means of repeated runs. The relative precision of the method for process inventory determination was estimated by generating random variables such as batch-to-batch variations or experimental errors. (auth)

21334 CONTRIBUTION TO SYSTEMS ANALYSIS OF NUCLEAR PLANTS. Larisse, J.; Matthes, W.; Mueller, K.-H.; Rota, A. (EURATOM, Ispra, Italy). pp 333-50 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

Systems analytical studies in the field of safeguards require an intimate knowledge of various facilities and of the entire fuel cycle so that their response to modifications in normal operating rules may be predicted. To this effect, fabrication and reprocessing plants were studied using simulation techniques. The results and future extensions of this work are described. (auth)

21335 APPLICATION OF A NUCLEAR PROCESS SIMULATION MODEL TO AN INTEGRATED SAFEGUARDS EXPERIMENT. Marcuse, W. (Brookhaven National Lab., Upton, N. Y.); Williams, J. M. pp 351-71 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

The technical studies program of the Office of Safeguards and Materials Management of the USAEC is conducting an experiment called the Plant Instrumentation Program in several plants. In at least one of these plants a program, the Integrated Safeguards Experiment, has been initiated directed toward evaluating the instrumentation in terms of its contribution to closing material balances with measurements and in decreasing the limits of error on the material unaccounted for across these closed material balance areas. An analytical model which is being used in the experimental design of the integrated safeguards experiment is now being developed. This tool, the nuclear process simulation model, has reached a stage of development where it is playing a key role in the planning of the integrated experiment and will play an important role in the conduct and evaluation of both the safeguards integrated experiment and the plant instrumentation program. The scope and objectives of the integrated safeguards experiment are discussed. The nuclear process simulation model is described. Examples are presented to show the application of the model to: planning of the experiment; providing feedback to the plant instrumentation program; and assessing and extrapolating the experimental results. Future plans for developing the model and applications to cost effectiveness analysis of safeguards alternatives are dealt with briefly. (auth)

21336 FUEL CYCLE STUDY FOR SAFEGUARDS SYSTEMS ANALYSIS. Shmelev, V. (International Atomic Energy Agency, Vienna). pp 373-85 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

For the purpose of safeguards systems analysis it is necessary to have an adequately detailed description of nuclear materials in the fuel cycle to which safeguards are to be applied. This description should include an assessment of the size of the nuclear materials system, the quantities and forms of nuclear materials contained in it and the distribution of materials among the various processes such as fuel elements fabrication, reprocessing of irradiated fuel, fuel use in reactors, etc. The study of nuclear materials systems as a part of safeguards systems analysis is carried out in the IAEA Department of Safeguards and Inspection. Characteristic reactor data and various dynamics of nuclear power growth are used as variable source data for a computer simulation program to calculate the distribution of nuclear material in various fuel cycles. The results of the analysis are printed out in the form of tables and graphs of nuclear materials quantities expressed in nominal kilograms, effective kilograms and kilograms of fissionable isotopes. The method and some results of the study are summarized. (auth)

21337 COST EFFECTIVENESS APPROACH TO INVENTORY VERIFICATION. Stewart, K. B. (Battelle-Northwest, Richland, Wash.). pp 387-409 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

The role of the verification of physical inventories is discussed. The main objective is to give currency to a technique which delineates a form that sampling plans and analysis can take in confirming facility-listed amount values. The important role that planning the survey should take is emphasized. Techniques for giving shape to the planner's sampling plan objectives are given by the manner of stating the alternative hypothesis, optimizing the allocation of effort and determining a sample size which gives adequate protection. (auth)

21338 OPTIMAL INSPECTION PROCEDURES IN A NUCLEAR FACILITY FOR A SEQUENCE OF INVENTORY PERIODS: A DECISION THEORETICAL MODEL FOR AN INSPECTION SYSTEM BASED ON MATERIAL MEASUREMENTS. Avenhaus, R. (Kernforschungszentrum, Karlsruhe, Ger.); Hoepfinger, E. pp 411-24 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

The safeguarding of fissile material in a nuclear facility by means of flow and inventory measurements was considered previously. It was shown in what way the probability of detection could be used in the case of one inventory period as a criterion for the cost optimization of the safeguards system. The following problem is discussed. A nuclear facility is considered, and an interval of time of length T; in this interval of time the inventory is taken n times (the interval of time T/n between two inventories is fixed by the postulate of a finite mean detection time). The optimal strategy of the inspector is considered, i.e., the optimal allowed limits for the difference between book inventory and physical inventory and the optimal estimates for the inventories at the beginning of an inventory period. As the inspector does not know the strategy of the operator, i.e., the method of diverting a given amount of fissile material in the interval T, all possible strategies

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of the operator have to be considered. For each strategy of the operator the minimum probability of detection is determined. That strategy of the inspector which maximizes this minimum probability of detection is the optimal strategy of the inspector. The case n = 2 is considered in detail; from this case conclusions are drawn for the general case. The optimized probability of detection again is used as the effectivity criterion for the cost optimization of the inspection procedures. (auth)

21339 GAMES THEORETICAL MODELS FOR INSPECTION PROCEDURES. Beinhauer, R.; Bierlein, D. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 425-46 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

A model for inspection procedures for a finite time interval is presented. The safeguarding of a nuclear facility should by timely detection prevent fissionable material from being diverted and, after a certain critical time, being utilized in the military sector. The model assumes that, after such a utilization, detection of the diversion is too late and no longer efficient. The essential point is therefore the timely detection of diversion, that is, a diversion should be detected within the critical time. The model considers a finite time interval, the time between two routine inventories. Safeguarding is achieved by intermediate inventories. Several closely related questions arise which are answered by the solution of the model: How many inventories should be undertaken and how should they be spread over the time interval? Given a limited budget for safeguards, can the inspection authority find an inspection plan which induces the operator to act legally? These questions, aimed at optimization, make sense only in relation to a pay-off function that involves the costs of inventories, a reward (for the inspection authority) in case of timely detection, and a penalty in the contrary case. The model is a zero-sum game with a simple pay-off function of this type. A model for more general inspection procedures is presented. This model is no longer restricted to a finite time interval. Similar questions to those in Part I arise but there are some new aspects. (auth)

21340 RAPID RESPONSE DIVERSION DETECTION IN THE PLANT SAFEGUARDS SYSTEM. Murphey, W. M.; Smith, C. N.; Perella, F. J.; Rowen, J. W. (National Bureau of Standards, Washington, D. C.). pp 447-57 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

A need exists to develop rapid response diversion detection tools. These rapid response procedures or tools are used in conjunction with material balance accounting to form a more sensitive system of indicating abnormal conditions in terms of quantity, location and time, and thereby eventual diversion. A number of possibilities for practical, economic, rapid response diversion detection are presented where the plant is considered as an independent system. A measure of the effectiveness or sensitivity of the tools in terms of the time response, mass response and space localization is presented. Rapid response procedures were devised relative to specific threats short of diversion as a policy of the plant management. These threats include diversion by individuals, groups, and the possibilities of changing the very records which are the basis of some safeguards tools. Examples of the specific types of threats considered and of the application of the tools are given for a particular fuel fabrication plant. The tools are applicable to domestic safeguards and would probably be administered by the plant management and/or the domestic safeguards authority. Some of the objectives of the rapid response approach are: to reduce the time delay between possible diversion and indication to the safeguards authority that a diversion may have occurred; to decrease the minimum size of diversion which can be detected; to localize the diversion more accurately within the plant; and to increase safeguards assurance without increasing the cost of the safeguards procedures by using currently available process control information. (auth)

21341 PANEL DISCUSSION: VIEWS ON PROGRESS IN SAFEGUARDS TECHNIQUES AND FUTURE ACTIVITIES. pp 461-74 of Safeguards Techniques. Vol. II. Vienna; International Atomic Energy Agency (1970).

From IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany. See STI/PUB-260(Vol.2); CONF-700701-(Vol.2).

Views on current progress in and future prospects for safeguards techniques are presented. Systems analysis (defined as applied common sense) in relation to safeguards, instrumentation, destructive and nondestructive measuring methods, and the cost and precision of safeguards systems are discussed. (L.C.L.)

21342 WASTE MANAGEMENT - PAST, PRESENT AND FUTURE. Burns, R. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 3-8 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The work of various atomic energy organizations as waste managers in the past (since 1965) is reviewed. Managers are admonished to always be cost conscious, but at the same time to insist that safety is first priority with costs secondary. Waste managers have acquired considerable expertise and could and should play an important role in solving waste problems of other industries. Also, managers should make a valuable contribution to the conservation of the environment. (auth)

21343 FRENCH POLICY ON THE MANAGEMENT OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTES. Souselier, Y.; Pradel, J. (CEA, Fontenay-aux-Roses, France). pp 9-25 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The development of the French nuclear program during the past decade has been one of the essential elements in the choice of a radioactive waste management policy. Ten years ago there was no immediate need for permanent storage sites: each center processed its liquid effluents so as to ensure that the amounts of radioactivity released did not exceed the limits laid down by the national authorities; the solid wastes, after sorting and in some cases decay storage, were processed in a suitable manner (by encasement in concrete or bitumen blocks). The possibilities of on-site storage prior to the choice of a permanent site were such as to allow relatively long periods of storage. However, the processing of uranium ores involved the de facto creation of permanent storage sites for the sterile residues left by acid attack. Even so, the first real permanent storage site for radioactive wastes was the one at Bauzot in central France, which operated from 1958 to 1969. A second stage in the permanent storage program was the sinking of radioactive wastes from Marcoule in the Atlantic Ocean, within the framework of international operations organized by ENEA. The final link in the current storage policy was the creation in 1969 of a storage center at La Hague in Normandy for radioactive wastes from the CEA centers in the Paris region, EDF power stations, hospitals, and private laboratories. Future policy will have to take into account more and more the economic factor, which will govern the choice between different methods capable of satisfying safety requirements; and these latter will vary according to the nature and half-life of the isotopes concerned. Thorough knowledge of sites and exact marking of the stored wastes are essential for land storage: a proliferation of sites is not desirable as the land is rendered useless for other purposes. This last factor, inter alia, should militate in favor of international cooperation of this field. (auth)

21344 MANAGEMENT OF RADIOACTIVE WASTES BY THE PORTUGUESE NUCLEAR ENERGY COMMISSION. Bettencourt, A. O.; Sequeira, F. P. C. (Commission de l'Energie Nucleaire, Sacavem, Portugal). pp 57-68 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Studies carried out at the Physics and Nuclear Engineering Laboratory on the construction of a waste processing station are described. The policy of the Portuguese Nuclear Energy Commission is to provide maximum support in the management of radioactive wastes originating in industry, medical institutions and research centers; this, combined with the fact that the Sacavém Center is at present the largest producer of radioactive wastes in the country, has resulted in that Center being chosen as the site for a national waste treatment station. The project has taken into account the wide variety of effluents that will have to be treated, the most common types of solid wastes and also requirements associated with the development of nuclear energy in Portugal. The establishment of the Center will also make necessary a fairly intensive decontamination of the effluents prior to discharge, even

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though the flow of the Tagus at this point is strong and there is an appreciable tide. These factors led to the choice of an installation incorporating a vertical-type evaporator for liquid effluents in general, a pilot plant for the chemical treatment of effluents from the purification of uranium or its compounds, an incinerator for burnable solid wastes, a workshop for processing slurries and ash, and a decontamination plant. The reasons for this choice are discussed, as are some of the economic considerations and the problems, which arose in connection with the choice of site. (auth)

21345 UNITED KINGDOM WASTE-MANAGEMENT POLICY. Kenny, A. W. (Ministry of Housing and Local Government, London). pp 69-90 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The aims of United Kingdom radioactive waste-management policy are to ensure that nobody receives a dose of radiation in excess of the appropriate limits recommended from time to time by ICRP, and to reduce the doses as far below those limits as is reasonably practicable. The legal powers to control waste discharges in accordance with these aims are described. For important wastes, the principle of the critical path approach guides the setting of limits for disposal; some examples are described in detail. For small users, a more general approach based on guiding limits deduced from hypothetical worst cases is followed; the limits are given. A few remarks are made on future waste-disposal problems and on the United Kingdom contribution to global problems in this field. (auth)

21346 RADIOACTIVE WASTE MANAGEMENT IN JAPAN. Ichikawa, R. (Nuclear Safety Research Assn., Tokyo). pp 91-9 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Radioactive wastes produced by radioisotope users all over the country are being collected by Japan Radioisotope Association to be forwarded to Japan Atomic Energy Research Institute for final treatment. Low- and intermediate-level liquid wastes from fuel reprocessing plant, which will be constructed in the near future, would be released into coastal seawater under appropriate control regulations. Many nuclear power plants are under construction and are planned for the near future throughout Japan because of the rapid increase of energy demand for several decades to come. In view of this, it is expected that radioactive solid wastes from the plants will accumulate year by year and exceed the storage capacity at these sites. The final disposal of these wastes is the most important problem to be solved in Japan. The feasibility of both terrestrial and marine disposal is being investigated under the specific conditions of Japan by the committee on radioactive solid waste management of Nuclear Safety Research Association. This problem involves many factors concerning waste treatment and packaging techniques, transportation, groundwater, oceanography, fisheries, environmental radiation safety, etc. The land burial of the wastes should not be allowed without careful consideration of the small land area and the high population density and also of the utilization of land by future generations. On the other hand, deep sea disposal should not be considered as an easy solution, because of the high utilization of marine products. To establish a national policy for radioactive solid waste management, the present study was concentrated on various weak points to be overcome, and individual technical questions to be investigated in the light of present knowledge. (auth)

21347 MANAGEMENT OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE LIQUID AND SOLID WASTES IN THE FEDERAL REPUBLIC OF GERMANY. Aurand, K. (Federal Health Office, Berlin); Schwibach, J.; Wolter, R.; Krause, H. pp 101-13 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The first part (Part I) of the paper deals with the principles and regulations for discharging radioactive waste waters into main canals. Based on ICRP-recommendations and Euratom Radiation Protection Standards, the First Radiation Protection Ordinance of the Federal Republic of Germany applies the concept of maximum permissible concentrations of radionuclides in water. As a rule, the maximum permissible concentrations of radionuclides in drinking water of radiation workers may not be exceeded in discharged waste water. Experience has shown that these regulations have led to the installation of expensive equipment, which is unnecessary by safety considerations. On the other hand, nuclear power stations, having a very large throughput of cooling water, could, if following this policy, release large amounts of radionuclides. Therefore, regulations have been formulated, which allow greater flexibility in the case of radioisotope users and which limit the total activity to be discharged from nuclear power stations. The license states that radioisotope users, according to the activity level and the radiotoxicity of the isotopes handled, have either to control the discharge by simple bookkeeping, or to measure in a holdup tank, or to decontaminate the waste water. The license of nuclear power plants states a concentration limit, so that liquid wastes of high concentrations must be decontaminated before discharge, whereas liquid wastes with a lower concentration may be discharged together with the cooling water. Furthermore the total activity to be discharged is restricted. The second part (Part II) deals with the management of low- and intermediate-level radioactive wastes. Liquid and solid radioactive waste-treatment methods employed by the different nuclear installations in the Federal Republic of Germany are outlined briefly and the experience gathered from their operation is summarized. New trends of development are indicated. The solidified radioactive residues are stored in an abandoned salt mine. Since 1967 low-level wastes have been stored there, within the framework of an experimental program. Preparations are being made to store intermediate- and high-level wastes. The storage volume of the mine is sufficient to accommodate the radioactive wastes expected to arise in the Federal Republic of Germany up to the year 2000, after further development of the technical facilities. (auth)

21348 MANAGEMENT OF LOW- AND INTERMEDIATE-LEVEL SOLID RADIOACTIVE WASTE IN THE NETHERLANDS. Baas, J. L. (Ministry of Social Affairs and Public Health, The Hague); Cornelis, J. Ch.; Smeets, L.; Verkerk, B. pp 115-24 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Because of serious risks of contaminating water supplies, bulky low- and medium-active solid wastes cannot be buried or stored in mines in the Netherlands. Since long-term above-ground storage is costly and inconvenient we have chosen sea-dumping as our ultimate disposal method. This decision was governed mainly by safety and economic criteria that were considered between the Government and RCN. A licensing system exists for the use and disposal of all fissionable and radioactive substances. This system applies to all categories of users — industry, laboratories, research, hospitals, etc. It is based on the Nuclear Energy Act, which also regulates waste storage and treatment. Licenses are granted by the Minister of Social Affairs and Public Health, sometimes together with or after consultation with other Ministers. A license imposes a number of special rules, e.g. restrictions of the quantity of radioactive nuclides used, and always on the storage of radioactive materials. Radioactive wastes must be stored and later disposed of by an officially recognized waste-disposal service. This service is organized by the Reactor Center at Petten. In the second part of the paper details are given of new installations built at RCN for treatment of these wastes and their preparation for sea-dumping. The installations mainly consist of a baling facility, using a 90-ton press mounted in a controlled area for pressurized-suit operations. Very recently the facilities were improved and the operations further mechanized to increase efficiency. The services of the central waste-treatment station can now be extended since a simple method of treating carcasses from tracer experiments with small animals has been found. This method is described in the paper. (auth)

21349 MANAGEMENT OF LIQUID AND SOLID RADIOACTIVE WASTES OF LOW AND INTERMEDIATE ACTIVITY IN ITALY. Branca, G.; Polvani, C. (Comitato Nazionale per l'Energia Nucleare, Rome). pp 125-37 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The main sources of both liquid and solid low- and intermediate-level radioactive wastes at present produced in Italy are described, together with some data concerning the amounts produced in a research nuclear center. After briefly reviewing the administrative procedures adopted in Italy with respect to the management of radioactive wastes and their disposal into the environment, the

evolution in recent years concerning the main criteria on which the disposal of liquid wastes into the environment is based is discussed. This evolution caused a shift from the concept of not exceeding given maximum concentrations in the waste waters or in the recipient waters to that of a maximum rate of radioactive substances, which can be discharged in a given environment as a function of its radiological capacity, evaluated through adequate ecological surveys. The influence that such criteria might have on the management of radioactive liquid wastes is briefly discussed. The present possibilities and the future perspectives concerning the ultimate fate of solid low- or intermediate-level radioactive wastes in Italy are discussed. (auth)

21350 LEGAL CONDITIONS FOR AND PRACTICAL APPLICATIONS OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE MANAGEMENT IN BELGIUM. Cantillon, G. E. (Institut d'Hygiene et d'Epidemiologie, Brussels). pp 139-53 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The radioactive waste problem in Belgium is described and the conditions in which such wastes can be legally stored or released into the environment specified. The legislation on water courses and nuclear facilities is outlined and the terms of different release authorizations are analyzed. The reasons for the choice of radioactive waste management policy are discussed. (auth)

21351 RECENT DEVELOPMENTS IN THE UNITED STATES LOW-LEVEL RADIOACTIVE WASTE-MANAGEMENT PROGRAM: A PREVIEW FOR THE 1970s. Belter, W. G. (U. S. Atomic Energy Commission, Washington, D. C.). pp 155-82 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Recent United States developments in power reactor waste management, land burial, sea disposal, and deep-well injection, are summarized, principally as they relate to the establishment and modification of existing or new waste-management policies and procedures. Power-reactor waste-management experience is described, including the significance of tritium and noble gas releases in these operations. While the release of heat from nuclear power plants is not unique, nevertheless, because of a lower thermal efficiency, light-water nuclear plants of current design discharge more waste heat to the environment than a conventionally fired plant of the same size. The radiological effects of low-level releases and the problem of heated effluents from nuclear power plants are interrelated factors when one considers the potential total impact of these operations on the environment. An expanded thermal effects research and development program is being developed by the United States Atomic Energy Commission in concert with other Federal and State government agencies and the utility industry to provide the technical basis for the safe development and public acceptance of nuclear energy. The scope of this emerging program is described. Because of the rapid growth of nuclear power and increasing uses of radioactive materials and other sources of radiation, the USAEC has proposed amendments to its regulations on radioactive effluents from light-water-cooled nuclear power reactors, to help ensure that total radiation exposures to the public from licensed atomic energy activities remain low. Bases for the amendments to the AEC regulations are discussed with their possible significance indicated. With the growth of the United States nuclear energy industry, disposal of solid radioactive waste materials by commercial land burial has also continued to increase. The magnitude of radioactive waste land burial, including the AEC and industrial operations, is summarized. Technical studies on the segregation and retrievability of solid wastes contaminated with transuranium nuclides from other waste materials in AEC operations are discussed. The disposal of solid waste materials by sea burial, has essentially ceased, primarily because of the availability of commercial land burial services. Developments in this area since the 1965 IAEA conference are summarized. Deep-well injection has become increasingly popular for the disposal of all types of industrial wastes, principally from the chemical, petrochemical, and steel industries. However, the technique has essentially not been used for the disposal of radioactive waste materials. The limitation of this waste disposal method and recent actions which have been initiated by the U.S. Department of the Interior to regulate and control these underground disposal operations are described. During the 1960s, an extensive research, development, and demonstration program was carried out on the treatment and disposal of all types of gaseous, liquid, and solid waste effluents. Waste-management technology is now available for the removal of radioactivity down to small fractions of authorized radiation protection guides. During the 1970s, major emphasis in the radioactive waste-management program will be placed on industrial application and the obtaining of public acceptance of this control technology. (auth)

21352 CANADIAN EXPERIENCE WITH A NATIONAL WASTE-MANAGEMENT FACILITY. Mawson, C. A.; Russell, A. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 183-94 of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Canadian waste management has been based on gathering radioactive waste in one place, rather than having regional waste-management areas. Apart from uranium mill tailings and some radium processing wastes, all such material has been handled by Atomic Energy of Canada Limited, mainly at the Chalk River Nuclear Laboratories site. The dispatch and transportation of wastes from distant parts of such a large country as Canada causes logistic difficulties, and even absurdities, which are described. Universities in particular, which are more likely than industry to accumulate putrefiable waste, raise objections to the system, and proposed changes are being studied. Collected wastes are nearly all buried in one form or another. It is shown that this procedure has been successful and safe for a variety of wastes exhibiting a wide range of activity and physical nature. The operations have been practicable and economically reasonable, even under adverse circumstances imposed by nuclear accidents and in sometimes severe climatic conditions. The considerations necessary for selecting a site suitable for establishing a central waste-management facility are outlined, and suggestions are made on regulations and principles of operation. During the twenty years of operation of the Chalk River facilities there have been several incidents providing experiences useful in illustrating important aspects of successful operation of a waste-management system. Practical examples drawn from this experience are used to illustrate the points made in this paper. (auth)

21353 DEVELOPMENT OF RADIOACTIVE-WASTE MANAGEMENT IN BRAZIL. Dos Santos, Lydia; Rodriges Machado, Tereza C. (Commission National de l'Energie Nucleaire, Rio de Janerio). pp 205-12 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Steps in the development of the radioactive-waste management system and the experience gained through the difficulties encountered when selecting general policy and waste-treatment methods are reviewed. In particular, the present solutions in practice and the future development envisaged in this field are described. (auth)

21354 FUTURE MANAGEMENT OF RADIOACTIVE WASTES IN AUSTRIA. Oszuszky, F. J. P. (Oesterreichische Verbundgesellschaft, Vienna); Schlosser, K. pp 213-24 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

For the time being the only radioactive waste producers in Austria are the nuclear research center at Seibersdorf, different research reactors, some laboratories, and all users of radioactive isotopes in industry and medicine. With the decision to erect a 600-MW(e) nuclear power station in Austria attention must now be directed towards the additional future wastes and their management. Active operation of this plant—which will be probably situated on the Danube River—is planned for the middle of the seventies. The Austrian reactor operators will only be concerned with a small part of the activity to be treated as far as waste disposal is concerned, since 99.9% of the fission products produced in nuclear reactors are handled in spent fuel reprocessing plants outside the country. In this connection the present and future national waste management policy in this country will have to be reviewed, particularly concerning the foreseen release of liquid waste to the Danube, which is an international waterway, necessitating special care regarding the dispatch of such releases. Safe waste disposal to such a river system without endangering its biological equilibrium, and the best compromise between cost of waste management with a high standard of safety are discussed. Also mentioned are the legal and economic aspects of waste management, the most suitable processes for waste treat-

ment and its storage, and the cooperation between waste producers and the national authorities and organizations responsible for a centralized service for waste collection, waste treatment and ultimate storage. (auth)

21355 MANAGEMENT OF RADIOACTIVE LIQUID WASTE AT THE BORIS KIDRIC INSTITUTE FOR NUCLEAR SCIENCES. Svabic, Ana; Bojovic, P.; Jankovic, Olga (Boris Kidric Institut des Sciences Nucleaires, Vinca, Yugoslavia). pp 225-31 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The results of experiments at the Boris Kidrič Institute for Nuclear Sciences on the management of radioactive liquid waste are presented and the general lines of the waste-management programs discussed. The types of liquid waste involved, the methods used in collecting it and the possibilities of its being discharged into the Danube are described. A description of a pilot station is also presented. (auth)

21356 OPERATIONAL EXPERIENCE IN THE HANDLING, TREATMENT AND DISPOSAL OF RADIOACTIVE WASTES AT A RESEARCH AND DEVELOPMENT ESTABLISHMENT. West, P. J. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 235-45 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The paper reviews operational experience in the handling, processing, and disposal of radioactive wastes at AWRE, Aldermaston. Much of the work of the Establishment is concerned with long-life alpha radioactive materials, and these form the principal contaminants of the wastes for disposal. The hazards associated with the handling and treatment of the wastes are therefore mainly those related to such materials, although there are some wastes with a radiation hazard arising from the operation of a 5-MW light-water-moderated research reactor and other nuclear assemblies. Reference is made to the authorizations granted to the Establishment for the disposal of radioactive wastes, and their influence on the treatment processes for the wastes. Both liquid and solid waste treatment processes are described in some detail, and the operational experience of these processes is reported. Plant modifications and new plant installations found necessary through operational experience are described. In general the contamination loading of the wastes has not changed greatly over the years, but operational experience has led to some advances in technology that have advantages in both the economy and improved safeguards of radioactive waste disposal. (auth)

21357 MANAGEMENT EXPERIENCE WITH RADIOACTIVE WASTES FROM ENEL NUCLEAR POWER STATIONS. Antonucci, L.; Bramati, L.; Fiorentino, F.; Malossi, S. (Ente Nazionale per l'Energia Elettrica, Rome). pp 261-74 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Experience with liquid- and solid-waste disposal at the three Italian nuclear power stations over a total of twenty years of operation are described. For each station, the sources of the wastes, the methods of disposal, and the amounts discharged are indicated. The improvements made on the basis of operating experience are also mentioned. (auth)

21358 MANAGEMENT OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTES AT THE NUCLEAR POWER STATIONS OF THE UNITED KINGDOM CENTRAL ELECTRICITY GENERATING BOARD. Dougall, I.; Newell, J. E. (Central Electricity Generating Board, London). pp 275-95 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI:PUB-264; CONF-700905.

The paper describes the management of low- and intermediate-level solid and liquid radioactive wastes arising at CEGB nuclear power stations. The arisings do not include wastes from chemical processing of irradiated fuel elements as the elements are returned to the UKAEA for processing. The paper outlines the factors determining the original and continuing policies of long-term accumulation of significantly active solid wastes on the power station sites, and of discharging liquid wastes to the environment at low level, if necessary after suitable treatment. Radiological safety and design aspects of the waste-management systems are discussed and the roles of the Board and of the Government Authorities in ensuring safety of operation are briefly described. Experience in waste management at Magnox reactor power stations is discussed together with modifications planned or under consideration. In a few cases waste storage arrangements have proved inadequate and facilities will have to be extended. Improvements include (a) provision of small on-site incinerators to cope with the large arisings of low or only nominally active wastes. (b) arrangements for the incineration of slightly contaminated waste oil at CEGB oil-fired power stations, and (c) provision of additional treatment plant to reduce levels of radioactivity in fuel-element cooling ponds, and thus to keep radioactive discharges within authorized limits. Attention is drawn to the importance of adequate monitoring of liquid waste discharges in ensuring that the operator is free to work up to the authorized limits without risk of exceeding those limits. Waste-management proposals for Mark II (Advanced Gas Cooled) and Mark III (High-Temperature Gas Cooled) reactors are described in the light of experience at Magnox stations, new kinds of wastes, and possibly new site conditions. For example, at inland sites discharge limits on activity in liquid effluent are likely to be stringent and development work has been undertaken with the object of ensuring that any necessary reduction in the level of discharges can be achieved. (auth)

21359 TECHNICAL AND ECONOMIC ASPECTS OF HANDLING THE RADIOACTIVE WASTES OF RESEARCH CENTERS AND ATOMIC POWER PLANTS OF THE SOVIET UNION. Kondrat'ev, A. N. (Radiation Inst., Leningrad); Khonikevich, A. A.; Sedov, V. M.; Rybal'chenko, I. L. pp 297-311 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

Three methods are used for decontaminating the wastes of research centres and atomic power plants—evaporation, ion exchange, and underground burial. The paper briefly analyses the technical and economic aspects of these methods and the decontamination costs for units with a capacity of 100, 250, and 500 m^3/day. The possibility of applying the three methods to water with low salt content and to radioactive solutions with a total salt content of 0.5 to 7 g/l is also discussed. The technical and economic criteria are based on the experience of operating the existing units for decontamination of radioactive wastes at the Atomic Reactor Research Institute, the Moscow Waste Treatment and Radiation Safety Station, the Leningrad Waste Disposal Station, and the Beloyarsk and Novovoronezh Atomic Power Stations. The individual items of expenditure for all the three waste decontamination systems having different capacities are analysed and compared. In addition, the basic technical and economic characteristics of the electrodialysis method are compared with those of the ion-exchange method. The problems of storing radioactive concentrates (evaporator concentrates and slurries) and solidification of these concentrates by incorporating them into cement and bitumen, together with the basic technical and economic characteristics of these processes are also discussed. Lastly, the conclusions and recommendations relating to the selection of waste decontamination systems in relation to chemical composition and capacity of the units from the economic point of view are presented. (auth)

21360 DEVELOPMENTS IN THE MANAGEMENT OF INTERMEDIATE-ACTIVITY SOLID WASTES AT THE SACLAY CENTER. Marque, Y.; Barral, S.; Belhomme, J. (CEN, Saclay, France). pp 331-45 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

After recalling briefly the reasons for selecting encasement in concrete blocks as a method of processing solid wastes, a critical assessment of this method and an explanation of why it was replaced by on-site decay storage at Saclay is offered. The new storage installations, which include leak-proof concrete pools, storage ponds for low-volume wastes and trenches for elements of larger size are described. The methods used to ensure radiological safety of operating personnel and for monitoring and protection of the site against radioactive contamination are also

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covered. Lastly, the essential elements of an economic assessment of this new storage method are outlined. (auth)

21361 DEVELOPMENTS IN THE MANAGEMENT OF LOW- AND INTERMEDIATE-ACTIVITY SOLID WASTES AT THE CADARACHE CENTER. Barbreau, A.; Marcaillou, J.; Mery, J.; Pinto, D.; Rancon, D. (CEN, Cadarache, France). pp 347-71 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

In 1970, at the Cadarache Nuclear Studies Centre, 11 reactors or critical assemblies were in operation. More than 164,000 m^2 are devoted to laboratories, testing areas, installations for the inspection of irradiated fuel elements, and plutonium technology workshops. Up to 1968 the low- and intermediate-activity solid wastes (categories 1, 2, and 3) collected at the Centre were divided into two classes for disposal purposes: (a) burnable wastes, which, after sorting, were destroyed in an incinerator; (b) compressible wastes, which were compacted in concrete containers after recovery of the packing by means of a 250-ton press. The situation at Cadarache and the results obtained in hydrogeological studies have prompted the Centre to improve the processing of these wastes and reduce the cost. The treatment of solid wastes should, in effect, be regarded as a step towards their final elimination. The measures envisaged at Cadarache were thus aimed at permitting final storage on site, in order to reduce the volume of waste, contain the activity and keep the cost to a minimum. The management of solid wastes is at present based on the following methods: (a) storage in trenches with PVC packing for non-burnable solid wastes of categories 1 and 4, after monitoring of specific activities; (b) compacting and storage in leak-proof pools for solid wastes of categories 2 and 3, the most highly active undergoing a period of decay storage beforehand; (c) incineration of burnable solid wastes of categories 1 and 2 and also of contaminated oils and solvents. (auth)

21362 HARWELL EXPERIENCES IN WASTE MANAGEMENT. Burns, R. H.; Clarke, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 419-32 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The experiences in waste management at AERE, Harwell are outlined. Details are given of the plant and equipment provided in 1947/48 together with the philosophy existing at that time. Modifications to plant and operational procedures have been introduced in the intervening years and the reasons for these are explained. Details of present waste production are given and present practices described. Finally, an assessment is made of the waste-management practices, which would be desirable today in a similar establishment in the same location. The assessment is based on existing knowledge and on the experience gained over the last twenty-two years. (auth)

21363 LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE-WASTE MANAGEMENT IN BELGIUM, IN PARTICULAR AT MOL. Van de Voorde, N. (BelgoNucleaire, Mol, Belg.); Cantillon, G. E.; de Raikem, Ch.; Detilleux, E.; Spriet, H. pp 433-59 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The radioactive waste-treatment plant of the Belgian Nuclear Center (CEN) was primarily designed to handle all radioactive residues which might originate from a classical nuclear center, assuming a normal extension and development. However, in addition to the normally expected waste produced by the CEN, there were relatively important quantities of radioactive waste originating from neighboring laboratories, hospitals and research centers. The Eurochemic Reprocessing Plant is a major contributor to the amount of wastes handled by the CEN Waste Facility. Indeed, pipelines connecting both sites ensure the transfer of all the low-level wastes ($<3 \times 10^{-2}$ β Ci/m^3), which represent about 95% of the total volume of liquid wastes produced by the reprocessing plant. The medium-active wastes ($<10^4$ β Ci/m^3), which represent 3.5% of its effluent production, are stored on the site in non-cooled tanks. Before storage some of these streams are concentrated in a batch evaporator working under vacuum. The results of this treatment and the storage facility are described. Various factors such as steady volume increase of liquid and solid wastes, higher activity levels, wide variety of waste composition, and strict requirements with respect to final conditioning of concentrates, brought about successive adaptations and constant improvement of the existing plants, such as standardization of containers and selective separation of active residues wherever appropriate. The treatment capacity was doubled in the liquid-waste processing plant. Moreover, thorough modifications were made to the plant where radioactive precipitates are concentrated before ultimate conditioning. During previous years, the operation of solid-waste processing (combustible and non-combustible) provided the routine experience needed to design and build, in the near future, more efficient, economical and reliable installations. Burning large quantities of diversified combustible waste in an incinerator provided with various gas-cleaning systems stressed the real usefulness of the incinerating process. Tests performed with a new pilot-scale oven proved it to be suitable for safe operation. (auth)

21364 INDUSTRIAL EXPERIENCE OF ON-SITE STORAGE OF RADIOACTIVE WASTES AT LA HAGUE. Barbreau, A. (CEN, Saclay, France); Bardet, G.; Escalier des Orres, P. pp 485-501 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The La Hague Center includes two separate permanent storage zones for radioactive wastes: the northwestern zone is used for the storage of wastes from the La Hague plant itself, the eastern zone for wastes received from users of radioactive products, power stations, and some CEA centers. Detailed geological and hydrogeological studies have demonstrated that safe storage is possible. Different forms of storage are used according to the nature and activity of the wastes: concrete silos, concrete-lined pits or trenches, trenches in open ground and surface storage areas. Storage of this type required numerous and well-chosen radiological checks and these are described in detail. (auth)

21365 DEVELOPMENT OF RADIOACTIVE WASTE MANAGEMENT AT THE FONTENAY-AUX-ROSES CENTER. Pomarola, J.; Feliers, P.; Testemale, G. (CEN, Fontenay-aux-Roses, France). pp 537-62 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The Center for Nuclear Studies at Fontenay-aux-Roses (CEN-FAR) is relatively small in area and is located near to built-up areas. The permanent storage of radioactive waste there is prohibited. Before 1960 the activities at CEN-FAR did not justify special installations for the treatment of radioactive waste and effluent at the Center itself and so they were transported to the Center for Nuclear Studies at Saclay for processing. The expanded activity of the reactors and of the plutonium laboratory, as well as the establishment of a number of installations, such as the plutonium chemistry and irradiated fuel laboratory, the irradiated fuel radiometallurgical laboratory, and the radioactive laboratory managers have led to the creation of the following facilities at the Center: a station for the treatment of low-level liquid waste (which has been adapted for the treatment of intermediate-level effluents); a plant for processing solid radioactive waste; an incinerator for contaminated animals and combustible waste, and a decay area for solid waste. There is also a decontamination station for reducing the volume of waste to be treated. These installations are briefly described and the resulting improvement in waste and effluent management is analysed. The changes made or planned in these installations with a view to increasing their output are discussed in conjunction with the increase in the amount of activity treated at CEN-FAR. (auth)

21366 MANAGEMENT OF RADIOACTIVE WASTE AT THE ISPRA ESTABLISHMENT. Fontaine, G.; Mosselmans, G.; Vaccarezza, J. (Commission des Communautes Europeennes, Ispra, Italy). pp 563-79 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The establishment at Ispra of the Joint Nuclear Research Center

of the European Community processes solid and liquid radioactive waste emanating from the Center's laboratory and reactors. For economic reasons the solid waste treated is stored at the site. The methods of treatment and also the methods of storage and burial used for each category of waste are described. (auth)

21367 WASTE MANAGEMENT AT TROMBAY: OPERATIONAL EXPERIENCE. Thomas, K. T.; Balu, K.; Khan, A. A. (Bhabha Atomic Research Center, Bombay). pp 581-99 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The paper describes the operational experience of the Waste Treatment Division, Bhabha Atomic Research Centre in waste management. Details are given of a liquid treatment plant for low-active waste (category 2), which has been in operation since June 1966. Consistent satisfactory efficiencies have been obtained with this plant, which uses a chemical precipitation technique followed by ion-exchange treatment with vermiculite. The plant has undergone several modifications since its commissioning in order to improve its performance and economy of operation. Details of such modifications and the improvements achieved are discussed. Account is also given of the operational experience in collection, transportation, and storage/disposal of radioactive waste. Details of operation in solid waste treatment and its disposal into the ground are discussed. A brief account is given of a vacuum distillation plant set up for the management of spent solvent from the Fuel Reprocessing Plant with a view to recover part of the solvent. The waste-management operational experience in Trombay has been quite satisfactory and has shown that radioactive waste produced, from either a nuclear research station or from an operating nuclear plant, can be satisfactorily managed provided adequate advance attention is given to the source, nature and quantities of the waste produced vis-a-vis the treatment. (auth)

21368 PHYSICAL AND CHEMICAL CRITERIA FOR THE DISPOSAL OF LIQUID RADIOACTIVE WASTE INTO VARIOUS GEOLOGICAL FORMATIONS. Spitsyn, V. I.; Balukova, V. D. (Inst. of Physical Chemistry, Moscow). pp 601-8 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In Russian).

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The physical and chemical criteria for the disposal of liquid radioactive waste into geological formations consisting of sandstones, siltstones, and carbonates are considered. The necessary conditions for compatibility between the wastes and the geological formations are discussed in the light of studies of the composition and properties of the wastes and the composition of the enclosing formations. A description is given of methods developed for treating liquid wastes before deep-well disposal. Chemical methods of increasing the useful lifetime of boreholes into which wastes are pumped under pressure (i.e., ways of unchoking the zone around the borehole) are described. A general account is given of the way in which biological processes affect this method of disposal and questions associated with gas generation in the storage stratum are discussed. Hydrodynamic questions relating to the permeability of the storage stratum and the quantity of wastes pumped into it are discussed. Data are presented on changes in the hydrodynamic parameters of the zone around the borehole and of the storage stratum as a function of the exploitation period, the quantity of waste, and the concentration of suspended matter. (auth)

21369 REPLACEMENT OF AN OLD TREATMENT PLANT: A DESIGN BASED ON EXPERIENCE. Emelity, L. A.; Christenson, C. W. (Los Alamos Scientific Lab., N. Mex.). pp 609-30 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

In autumn 1967, a new facility for the treatment of radioactive liquid waste, whose principal contaminant is plutonium-239, was placed in service in Los Alamos. Experience gained in treating the wastes in a pilot plant was utilized in the design. Between the preliminary planning stage and the first years of operation, however, several major changes were incorporated. These were influenced by a drastic reduction in funds and development of a continuous method for processing certain category-4 wastes. Details of the engineering design of the plant are discussed and efforts to produce an effluent meeting drinking-water standards are described. Though the main effort is necessarily directed at removal of alpha radioactivity, reduction of total solids, nitrates, and fluorides is also essential. Innovations contemplated and those recently added to provide a higher quality effluent are discussed. The three principal waste streams to the plant, classified on the basis of radioactivity as categories 2, 3, and 4, are processed by continuous methods, the lower activity wastes by chemical means and those of higher activity by mixing with cement. Steps in the development and improvement of the process for mixing category-4 wastes with cement are described, and sampling and monitoring methods are detailed. Studies of the paste product to determine compositions for maximum leach resistance are still underway and effects of parameters such as water/cement ratio, types of solids, etc. are being investigated. Descriptions of old (as much as eight years) cement paste leach samples are provided and comments on leach-test procedures are included. Category 2 and 3 wastes are treated by chemical means using ferric sulphate at a relatively high pH. Sludges from the system are mixed with cement and buried. Design of a system for continuously monitoring and recording the alpha radioactivity in several influent waste streams is detailed. Two-inch-diameter NaI crystals are used to detect the 20-kV x-ray emitted by plutonium. Maintenance problems due to excess lime accumulations in the filter are mentioned and the use of dry-ice converters in the recently added recarbonation system is outlined. A brief description of work underway to contain tritium in a compound from which it cannot be leached is also included. (auth)

21370 EXPERIMENTAL OPERATION OF A FACILITY FOR UNDERGROUND DISPOSAL OF LIQUID RADIOACTIVE WASTE. Spitsyn, V. I. (Inst. of Physical Chemistry, Moscow); Balukova, V. D.; Yudin, F. P.; (and others). pp 633-48 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

An English version of this paper is available in JPRS-51948.

In April 1966 an experimental facility for disposal of radioactive decontamination solutions in the R-3 geological exploratory well, which leads to a water-bearing horizon at a depth of 1432 to 1508 m, was put into operation at RRI. During the past four years 320,000 m^3 of solution, containing about 3500 Ci of beta activity, have been injected into this horizon. The purpose of putting the experimental facility into operation before completion of the geological prospecting work and the design of an industrial facility was to investigate, on an industrial scale, the burial of radioactive wastes of complex chemical structure in deep aquifers containing highly mineralized stratal waters. Operation of this facility has yielded a great deal of information of value for assessing the technical, economic, and radiation-health soundness of underground radioactive waste disposal in the conditions investigated; it has provided the data needed to justify an industrial facility and has indicated methods of constructing and adapting the wells. Information about the construction of the experimental facility and the results of the initial operating period was reported in 1967 and in 1968. In this paper the results of hydro-geological investigations carried out up to the beginning of 1970 are considered. The reasons for choosing particular absorptive formations are given and the layout of wells for the industrial facility is shown. General information about the work of the facility over the four-year period, together with an analysis of the basic data obtained from it, is also given. The technology used in preparing the solutions for disposal makes them compatible with the stratal waters and the rock of the stratum. No significant silt deposition in the filtration zone of the wells has been noted. The somewhat reduced capacity of the R-3 well is due to an increase in layer pressure over time. The injected solutions have been found to move further along the aquifer from the R-3 well than was originally expected. This movement has been observed mainly in a seam of some 6-10 m width, which lies at the top of the formation. Answers to all questions associated with the migration of radioisotopes and the movement of the injected waste solutions through the formation are given. (auth)

21371 INCINERATOR FOR RECOVERY OF PLUTONIUM FROM BURNABLE WASTES. Lefevre, C. (CEA, Bagnols-sur-Ceze, France). pp 657-68 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

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Organizations concerned with the reprocessing of irradiated fuels, plutonium utilization and research on plutonium chemistry produce a considerable quantity of waste material made up essentially of PVC, Latex, and Sopalin-cotton which also contains plutonium. The plutonium concentration in these wastes has been considered large enough to justify recovery, and it was thought at Marcoule that incineration of these wastes would make it possible to eliminate them and at the same time to recover the plutonium from the ash. Preliminary experiments confirmed that all the plutonium was in fact to be found in the ash. The paper describes the unit used for treating the wastes (reception and sorting, detection of metallic objects, grinding) as well as the incinerator. The ground waste material is introduced continuously into a furnace heated electrically to 900°C. Combustion is provided by the injection of dry air. The gas products are mixed with excess air and burnt in a postcombustion chamber heated electrically to 1200°C. These products are then cooled by air dilution and subsequently in a heat exchanger and, after filtration, are released into the atmosphere. The incinerator is being built and will go into service in September 1970. (auth)

21372 DEVELOPMENT WORK ON THE HOMOGENEOUS INCORPORATION INTO BITUMEN OF INTERMEDIATE-LEVEL WASTE FROM THE EUROCHEMIC REPROCESSING PLANT. Hild, W. (EUROCHEMIC, Mol, Belg.); Detilleux, E.; Eschrich, H. Lefillatre, G.; Tits, E. pp 689-724 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

To provide a solidification system, capable of treating both the intermediate-level waste streams accumulated during the chemical decladding operations and those produced during reprocessing operation with mechanical decladding, Eurochemic has decided to adopt the homogeneous incorporation of these effluents into blown bitumen. The need to investigate rapidly and effectively the problems concerned with the realization of such a solidification plant has led to the adaption of a combined development program, linking Eurochemic research activities with other international research and development resources. The paper describes the main points and the status of the main development activities, such as those related to: The definition of the chemical pretreatment flow-sheet for the different intermediate-level waste streams, before the incorporation into blown bitumen; the investigation of explosion risks and the definition of safety margins, both with regard to operation conditions and waste composition, research work performed in collaboration with the Belgian Royal Military School; the investigation of the safety aspects related to the radiolytical integrity of the solidified waste products, a development program performed in cooperation with the CEA Marcoule; and the solution of the technological aspects, especially the definition of the optimal screw extruder lay-out for the bituminization, development work performed in close cooperation with the CEA Marcoule, GfK, and the manufacturer of the extruder. In conclusion, a brief description of the Eurochemic solidification plant project is given. (auth)

21373 DISPOSAL OF RADIOACTIVE WASTES BY STORAGE IN A SALT MINE IN THE FEDERAL REPUBLIC OF GERMANY. Albrecht, E. (Gesellschaft fuer Strahlenforschung mbH, Munich); Kuehn, K.; Perzl, F.; (and others). pp 753-71 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

A program of scientific research and technical development for the final disposal of radioactive wastes in the Asse salt mine is discussed. After surface and underground repairs were carried out on the mine 7500 200-litre drums with low-level radioactive wastes (total activity about 150 Ci) have been disposed of in rooms at the 750 m-level since April 1967. The drums were transported by railway containers to the Asse mine. In the beginning they were lowered into the mine by a special hoist and transported by diesel trucks to the storage room where they were stacked, four standing on top of each other. In the later storage phase the drums were piled up in tens on top of each other to more efficiently utilize the storage room. The storage rooms will be sealed after complete filling. Experience related to the storage is described. The conditions prevailing at the Asse salt mine and its technical installations, like those of the hoist system, entail special requirements regarding the size and weight of the waste packages to be stored. In addition, the radioactive wastes must meet some special requirements when stored in a salt mine. The specifications necessary for accepting the radioactive wastes in the Asse salt mine are explained in the light of safety considerations. Their influence on the techniques of waste treatment are discussed. The technique of storing intermediate-level wastes is still in the testing stage. The waste drums must be transported into the mine in shielded containers. A loading system specially developed for this purpose enables the waste drums to be placed in a storage chamber under completely safe operation conditions The technology, throughput, and the advantages and drawbacks of the methods, are discussed and the storage operations predicted for the near future are described. (auth)

21374 INFRA-RED-HEATED EVAPORATOR SYSTEM FOR CONCENTRATION OF RADIOACTIVE EFFLUENTS. Hirling, J.; Pavlik, O. (Inst. of Isotopes, Budapest). pp 773-85 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

For volume reduction of different radioactive liquids and spent regenerants of ion-exchangers, new installations were constructed, providing successful operational experience. During operation of the conventional, steam-heated kettle-type evaporators, substantial difficulties have arisen regarding the incrustation and foam-generation hazards, requiring a particular vapour-cleaning process and continuous personal inspection. The new liquid-waste evaporator is operated by dark illuminating infrared heater elements. Since the vaporization is carried out below boiling point, only very low concentrations of aerosols enter the vapour phase; thus, their separation is unnecessary. Because of the surface-evaporation process the incrustation and foam-generation hazard are also eliminated. The ir-heated evaporator operates continuously in underground tanks, without constant inspection, and the energy transfer in a sealed circuit is very effective. In spite of the relative low capacity of the ir evaporator, it is economic and sufficiently effective because of long-term, continuous and uninspected operation. (auth)

21375 FUTURE GOALS IN RADIOACTIVE WASTE MANAGEMENT. Slansky, C. M. (International Atomic Energy Agency, Vienna). pp 787-93 of Management of Low- and Intermediate-Level Radioactive Wastes. Vienna; International Atomic Energy Agency (1970).

From Symposium on developments in the management of low and intermediate level radioactive wastes; Aix-en-Provence, France (7 Sep 1970). See STI/PUB-264; CONF-700905.

The present practices in the management of low- and intermediate-level radioactive waste are summarized, and the probability of further reducing the rate of radionuclide release to the environment in waste-disposal operations is discussed in terms of available technology, new process research, and economic restrictions. Those waste-management operations involving "dilute and disperse" policy are of greatest relevance to the discussion although reference is made to several "contained" solid-waste processes. Wastes from the following operations were analysed in this study: waste water, sands and slimes from the uranium mining industry; waste from the use of radioisotopes in industry; radioactive wastes from research laboratories; coolant, wash-down water, decontamination liquid waste, and miscellaneous solid wastes from nuclear power plants; and low-level liquids and solid wastes from nuclear fuel reprocessing plants. (auth)

21376 SAFETY MEASURES ASSOCIATED WITH THE DEVELOPMENT OF ATOMIC ENERGY. SAFETY IN FUEL FABRICATION FACILITIES. Haginoya, Toru (Mitsubishi Metal Mining Co. Ltd., Tokyo). Genshiryoku Kogyo; 16: No. 4, 121-4(Apr 1970). (In Japanese).

Fuel processing concerns the processes of converting such fuel materials as uranium, thorium and plutonium into the forms usable in nuclear reactors. Safety in such processing facilities is discussed in three parts: safety control in general, radiation control, and criticality control. In this connection, there is wide variance in radioactivity and fissile nature, and in chemical nature, depending on the particular nuclear species. In Japan, the fuel processing facilities include the conversion into uranium dioxide and its fabrication, for low enriched uranium, and fabrication of 90% enriched uranium–aluminum alloy fuels. The safety in fuel processing facilities is described as follows: safety criteria, including radiation and criticality controls; radiation control, including personnel, in-plant and out-of-plant; and criticality control, including fundamentals and practice in the plant. (Japan)

21377 RADIOACTIVE MATERIAL HANDLING AND STORAGE APPARATUS. Lecuyer, Daniel (to Societe AGS, Societe Anonyme) U. S. Patent 3,560,747. 2 Feb 1971. Priority date 20 Dec 1966, France.

Radioactive material handling and storage apparatus is described, including a storage block containing a bore for receiving a holder of a source of radioactive energy. The invention is characterized by the provision of means automatically operable upon insertion of the source holder in the bore to effect insertion of a protective closure member in the bore into engagement with the source holder, whereby the holder is shielded to prevent the escape of radiation from the bore. (Official Gazette)

21378 CONTAINER MEANS FOR A RADIOACTIVE ELEMENT. Lecuyer, Daniel (to Societe AGS, Societe Anonyme). U. S. Patent 3,560,749. 2 Feb 1971. Filed 16 Jul 1968.

A storage container is described for a radioactive element, including a housing having a central compartment arranged between a pair of end compartments, said central compartment being adapted to interchangeably receive one of a plurality of different sized shielding bodies into which a radioactive element is protectively stored. The storage body is supported within a tubular housing the opposite ends of which are mounted in corresponding counterbored recesses contained in the end walls of the central compartment. (Official Gazette)

21379 ASSESSMENT OF THE LEVEL AND SOURCES OF RADIOACTIVITY OF THE AIR AT THE SADKIN ASPHALT MINE. Pritchin, B. P.; Torskii, P. N. Gig. Tr. Prof. Zabol.; 14: 48-50 (May 1970). (In Russian).

Assessment of the level and source of radioactivity of air in the Sadkin Asphalt mine indicated that the high level of radioactivity was due primarily to the presence of radium in the rock. The measured content of radon in air in the mine was nearly 0.5×10^{-10} Ci/l. However, even poor ventilation of the mine significantly reduced the radon content. Thus, in ventilated areas the content of radon was quite low. (R.V.J.)

21380 L-3 AND L-10 SHIPPING CONTAINERS (3 Sep 1970) (Engineering Materials). (Atlantic Richfield Hanford Co., Richland, Wash.). (CAPE-2059)

8 drawings.

Two polyethylene bottles and their packaging are described. The bottles, which are identified as L-3 (three-liter) and L-10 (ten-liter) are used to ship $Pu(NO_3)_4$ by motor, air, or rail freight. The bottles are closed with standard 83mm vented carboy closures. The L-3 is 4.740 ± 0.125 in. OD and $16\frac{5}{16}$ in. high with a wall thickness of at least 0.100 in. and is contained in a pressure chamber which is comprised of a closed $19\frac{1}{4}$ in. length of 5 in. Sch 80 pipe. The L-3 is supported by a cage consisting of four pieces of $\frac{3}{4}$ in. OD carbon-steel tubing and is packaged in a 55-gallon steel drum $22\frac{1}{2}$ in. ID and $33\frac{1}{4}$ in. high. The L-10 is 4.430 to 4.570 in. OD and $50\frac{1}{4}$ in. high with a wall thickness of at least 0.165 in. and is contained in a closed 53 in. length of 5 in. Sch 80 pipe. The L-10 is supported as is the L-3 and is packaged in two open-top 55-gallon drums assembled top-to-top. Loose vermiculite is packed around the pressure chambers, and bagged vermiculite is used above the chambers. (For details see TID-4100 Suppl 63.) (See also NSA 25: 2415.) (TSS)

21381 DISPOSAL OF RADIOACTIVE XENON WASTE. Klein, Russell C.; Nelson III, Joseph A.; Pugh, Newell O. (Charity Hospital, New Orleans). Amer. Rev. Respirat. Dis.; 103: 118-19(Jan 1971).

Equipment and method for storing used radioactive Xe until its radioactivity is not harmful are described. The method was developed for hospital laboratories. It incorporates provisions for the user to breathe room air, or breathe room air and exhale into the waste system. (J.R.D.)

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INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 22578.

General Detectors and Monitors

Refer also to abstracts 20932, 21687, 21699, 21700, 21715, 21718, 21719, 21754, 21757, 21758, 21762, 21772, and 21905.

21382 (ANL–7760(Pt.2), pp 154-75) REGULARIZATION UNFOLDING OF LOW γ-RAY ACTIVITY MEASUREMENTS. II. EVALUATION OF TIME-OF-FLIGHT SCANNING IN ONE DIMENSION. Abu-Shumays, I. K.; Hess, P. E.; Marinelli, L. D. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969–June 1970.

The investigation of the potential usefulness of plastic scintillator rods as "time-of-flight gamma-ray cameras" for the mapping of the measured distribution "spectra" of low-level radioactivities in vivo is reported. The relationship between the distribution of the activity and of the corresponding scintillations in the camera is described by a Fredholm equation of the first kind. The spectra corresponding to three linear sources at a distance of (about) 10 cm from the rod are measured without collimation. The measurements are repeated in the presence of a 2-cm × 2-cm lead and also a 2-cm × 2 cm-tungsten brick collimator. The resulting spectra are unfolded by a regularization (smoothing) technique. Therefore, the applicability of the regularization technique to the solution of Fredholm equations of the first kind when the kernel of the equation (the response to a point source) has a wide FWHM (full width at half maximum) and is also asymmetric and dependent on the position on the rod, especially in the presence of collimation is demonstrated. (auth)

21383 (ANL–7760(Pt.2), pp 176-201) A SPECIAL REGULARIZATION-UNFOLDING TECHNIQUE FOR THE NUMERICAL SOLUTION OF TWO-DIMENSIONAL FREDHOLM EQUATIONS OF THE FIRST KIND. Abu-Shumays, I. K.; Marinelli, L. D. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969–June 1970.

Density functions, such as the density of radioactivity in vivo, are related to the measured distribution "spectra" of their signals by Fredholm equations of the first kind. The experimental and statistical errors in a measurement may render the corresponding solution for the density function physically meaningless in the absence of additional constraints. This paper attempts the solution of two-dimensional Fredholm equations where the physical kernel can be approximated by a separable kernel. It introduces a smoothness constraint on the solution which results, essentially, in smoothness by convolution. Two numerical experiments are given. (auth)

21384 (ANL–7760(Pt.2), pp 208-16) APPLICATION OF CELLULOSE NITRATE FILMS FOR ALPHA AUTORADIOGRAPHY OF BONE. II. RESOLUTION AND SENSITIVITY OF CELLULOSE NITRATE FILMS. Simmons, D. J.; Fitzgerald, K. T. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969–June 1970.

High resolution autoradiographs of thin line ^{239}Pu sources were prepared with several nuclear emulsions and cellulose nitrate (CN) films. The CN detector films made by the dipping method afforded better resolution of alpha tracks (after chemical etching) than Kodak Type A plates or AR-10 stripping film. Resolution could be improved by using thicker (30 μ) rather than thinner (15 μ) detector films. Tentative correction factors for alpha track counting in the CN films are presented. (auth)

21385 (BRH/DEP–71-2) ELECTRONIC X-RAY PULSE COUNTER. Walchle, R.; Grove, G. F. Jr. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Jan 1971. 18p. NTIS.

An inexpensive, easy-to-build x-ray pulse counter for measuring exposure times of pulsed x-ray machines is described. Knowledge of the rectification type in the machine and the line frequency allows conversion from number of pulses to exposure time. The instrument will count at rates as low as 2.2 mR per pulse and displays the result on a digital readout. The system employs a semiconductor detector. (auth)

21386 (DSL-TN–133) COINCIDENCE ERRORS IN PARTICLE COUNTERS. Thompson, G. H. (Defence Standards Labs., Maribyrnong (Australia)). Jun 1970. 8p. NTIS (U. S. Sales Only).

A theory of coincidence errors in particle counters is developed assuming three types of interaction between the pulses produced by the particles in passing through the sensing volume. Expressions are given, relating the true particle count to the apparent particle count at zero threshold for all three types of interaction. For the simplest type of interaction the theory is extended to cover the case of non-zero threshold. (INIS)

21387 (UCRL–20229) LAMINOGRAPHIC EXCITATION CAMERA FOR THYROID IMAGING. Kaufman, Leon; Perez-Mendez, Victor; Powell, Malcolm (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1970. Contract W-7405-eng-48. 9p. Dep. NTIS.

A camera is proposed for the laminographic imaging of the thyroid without administration of radiopharmaceuticals to the patient. An external source of gamma-rays is used to excite the characteristic x-rays of natural iodine in the patient's thyroid, source geometry limiting excitation to well defined planes. The camera consists of a parallel hole collimator and a xenon-filled proportional wire chamber with digitized readout of coordinates. Pulse height selection is provided to limit events in the image display to a selected energy range. The system obtains high resolution laminography for local exposures on the order of 1 Rad, with exposure times of a few minutes for each laminogram. (auth)

21388 PHOTOIONIZATION GAS-DISCHARGE RADIATION COUNTERS FOR THE RANGE 1050 TO 2000 A. Sorokin, L. S.; Adamchuk, V. K.; Dmitriev, A. B. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 885-6(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 216-18(May-Jun 1970).

Characteristics are given for G–M and ionization chambers at 1050 to 2000 Å. (auth)

21389 OPERATION OF A SLOW SCINTILLATOR IN A FAST-COINCIDENCE CIRCUIT. Andreev, E. A.; Sit'ko, S. P.; Shevchenko, V. A. (Kiev State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 803-4(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 150-1(May-Jun 1970).

A current amplifier which operates in a fast-coincidence channel from a slow scintillator is described. The input resistance is ≤10 Ω, the rise time is approximately 5 nsec, and the current gain is 10. For operation with NaI(Tl) crystals a resolving time of approximately 3 nsec was obtained. (auth)

21390 PULSED LIGHT SOURCE SIMULATING RADIATION FROM A SCINTILLATING PLASTIC. Aleksandrovich, K. V.; Berezin, I. A.; Gorbachev, V. M.; Uvarov, N. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 777-8(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 127-8(May-Jun 1970).

A light source whose spectrum is close to the spectrum of the radiation from a scintillating polystyrol-based plastic is described. The source is intended for checking and calibrating photo devices used in scintillation detectors of varying sensitivities, without using ionizing radiation. (auth)

21391 INVESTIGATION OF THE LIGHT COLLECTION CHARACTERISTIC OF LIGHT CONDUCTORS. Denyak, V. M.; Nemashkalo, A. A.; Afanas'ev, V. D.; Startsev, V. I. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 774-6(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 124-6(May-Jun 1970).

The experimental dependences of the light collection of conical light conductors on the conicity, the height, and the flash location are given. A method for equalizing the light collection characteristic for scintillation detectors is described. (auth)

21392 TRANSPARENCY OF A POLYSTYRENE-BASE PLASTIC SCINTILLATOR TO ITS OWN RADIATION. Gorbachev, V. M.; Uvarov, N. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 772-3(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 123-4(May-Jun 1970).

A study is reported of the light yield as a function of size on excitation by γ rays. Absorption by the material leads to a nonlinear dependence of yield on height. The attenuation coefficient is deduced for a polystyrene-base material containing 2% PPP and 0.06% POPOP. (auth)

21393 EFFECT OF THE OPTICAL CHARACTERISTICS OF NaI(Tl) SINGLE CRYSTALS ON THEIR SCINTILLATION PROPERTIES. Tsirlin, Yu. A.; Gurevich, N. Yu.; Mokhir, E. P.; Budilov, I. S. (All-Union Scientific-Research Inst. of Single Crystals, Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 767-9(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 120-1(May-Jun 1970).

The effect of the optical characteristics of NaI(Tl) single crystals (the light absorption coefficient, the light luminescence in the crystals, and the light-collection coefficient) on their scintillation properties is described. The relationship between the absorption coefficient and the intrinsic resolving power of scintillation detectors based on NaI(Tl) single crystals is found. It is shown that to a considerable extent the optical characteristics determine the scintillation properties of NaI(Tl) crystals manufactured by Soviet industry. (auth)

21394 MULTICHANNEL SYSTEM FOR MEASURING THE PHOTOFISSION YIELD. Ishkanov, I. M.; Kapitonov, I. M.; Pekar, M. I.; Piskarev, I. M. (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 741-3(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 98-100(May-Jun 1970).

A system for measuring the yield of the photofission reaction was constructed. The yield of the reaction was measured by directly registering the fission fragments using spark chambers operating in air. The multichannel counting system makes it possible to measure the yield curves from eight different reactions simultaneously. The system was tested on the 35-MeV betatron of the Scientific-Research Institute of Nuclear Physics, Moscow State University, Moscow. (auth)

21395 PERFORMANCE PARAMETERS OF A NEUTRON DETECTION UNIT. Sokolova, Z. Ya.; Chernyaev, V. B. (Ioffe Inst. of Physics and Tech., Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 733-4(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 90-2(May-Jun 1970).

Comparative measurements of neutron recording efficiency and sensitivity to γ emission on the part of neutron detection units using different types of scintillation detectors and photomultiplier tubes are cited. (auth)

21396 AUTOMATIC CONTROL OF THE DRIFTING PROCESS FOR SEMICONDUCTOR RADIATION DETECTORS. Erramuspe, H. J.; Sinderman, J. E. (Comision Nacional de Energia Atomica, Buenos Aires). Rev. Sci. Instrum; 42: 373-6(Mar 1971).

An automatic Li drifting apparatus is presented which controls the temperature of the detector bath to maintain the leakage current at a preselected value. When the Li ions reach the back of the wafer the temperature is automatically reduced to room temperature, leaving or not, optionally, the bias voltage applied. The need for constant supervision is therefore eliminated. (auth)

21397 SOLID-STATE PRECIPITATION DETECTORS FOR NUCLEAR TRACKS: A DEVICE FOR GROWING LARGE SERIES OF DOPED MONOCRYSTALLINE AgCl SHEETS. Zoergiebel, F.; Hasse, G.; Henig, G.; Schopper, E.; Schott, J.-U. (Univ., Frankfurt am Main). Z. Angew. Phys.; 30: 316-20(1970).

A device is described for growing series of sheets of AgCl crystals on quartz-glass plates in a definite gas atmosphere. The device allows the simultaneous production of a series of crystal sheets of various doping concentrations and of various doping components. The single sheet is 25 × 15 mm^2 size and consists of several (up to ~8) monocrystalline areas, which originate from a polycrystal of about 10^4 crystallites. Details of the procedure are given and micrographs of grown crystals are shown. (auth)

21398 SUPERSATURATED VAPOR OF CRYSTALLINE SUBSTANCES AS A POSSIBLE MEDIUM FOR REGISTRATION OF THE CHARGED PARTICLE TRACK. Dronov, V. S.; Gorbatenko, L. S. (Inst. of Railroad Transportation Engineers, Rostov-on-Don, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 66-9(1970). (In Russian).

Saturated vapors of solid crystalline substances were used for observations of charged particle tracks. The track should be marked by a chain of crystals growing from the vapors. The saturation and sensitivity period at various magnitudes of the charge of the formed ion centers, in the vicinity of which takes place the generation and growth of crystals, was calculated using a $C_{10}H_8$ specimen. (tr-auth)

21399 PROPORTIONAL COUNTERS. Emery, E. W. (Hammersmith Hospital, London); Gross, W.; Rossi, H. H.; Wilson, K. S. J. pp 10-18 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

A proportional counter placed in a radiation field may be regarded as simulating a very small volume of condensed matter, such as tissue. The pulse-height spectrum from the counter is closely related to the spectrum of energy deposition in the corresponding small volume. Recent progress in the development of counters for use in this way is reviewed. Artefacts may be introduced by the presence of the counter wall, but these may be avoided by the use of "wall-less" counters in which the collecting volume is defined by the electrical field arising from a lightweight electrode assembly. Such counters show clearly the effects of delta rays from tracks that do not themselves pass through the collecting volume. (auth) (UK)

21400 ASSESSMENT OF A LOW-PRESSURE CLOUD CHAMBER FOR MEASURING THE SPATIAL DISTRIBUTION OF IONIZATION PRODUCED BY HIGH-LET PARTICLES. Delafield, H. J.; Holt, P. D. (Atomic Energy Research Establishment, Harwell, Eng.). pp 35-41 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The potentialities of a low-pressure cloud chamber for measuring the spatial distribution of energy deposition by ionizing particles of low energy were investigated. Experimental studies, using pulsed 1.5-keV characteristic Al x rays, showed that at low pressures (10 cm Hg or less) a cloud chamber must be operated with considerable precision to avoid the diffusion of ions during the early stages of droplet growth. Chord ranges of electrons down to about 1 keV can be measured but individual droplets cannot be readily resolved. Theoretical considerations showed that the ultimate performance of such a chamber is dependent upon the lowest operating pressure which can be utilized before diffusion becomes significant, and upon the resolution of the optical system. Using an improved expansion mechanism it should be possible to resolve the details of the tracks of particles whose LET does not exceed 10 keV μm^{-1} in unit density material. They observed chord ranges of the electrons produced in the chamber, of energy E = 1.0 to 1.5 keV, were consistent with the range–energy relationship $R = 4.55\ E^{1.5}\ \mu g\ cm^{-2}$. (auth) (UK)

21401 MEASUREMENT OF LOW ENERGY RADIATION FROM RADIOACTIVE SUBSTANCES. Kimmel, H. French Patent 1,579,833. 1 Jul 1969. Priority date 13 Sep 1967, Germany. (In French).

A flowthrough ionization chamber for low-energy radiations is described. The window is composed of a fine-wire grating. (J.F.P.)

21402 USE OF ^{235}Np FOR THE CALIBRATION OF PLUTONIUM LUNG COUNTERS. McConnon, D. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Int. J. Appl. Radiat. Isotop.; 21: 744-7(Dec 1970).

An experiment was designed to calibrate sensitive ^{239}Pu lung counters following the inhalation by human volunteers of ^{235}Np as a substitute for ^{239}Pu. Neptunium-235 has radiological properties which should make it an acceptable substitute for ^{239}Pu such as an x-ray spectrum identical to that of ^{239}Pu, high-energy x-ray emission permitting reliable deposition measurements and no high-energy corpuscular radiation or radioactive contaminants which might produce an unacceptably high radiation dose to volunteers. Doses received by volunteers in such an experiment with ^{235}Np are estimated to be well within limits specified by the ICRP for occupational exposure. (auth) (UK)

21403 MONITOR FOR ^{133}Xe CONTAMINATION OF AIR. Rudin, Stephen; Hart, Hiram (Montefiore Hospital and Medical Center, Bronx, N. Y.). J. Nucl. Med.; 12: 145-6(Mar 1971).

The calibration of a detector (unshielded gamma-sensitive G–M detector) for monitoring background radiation levels from xenon-133 airborne contamination is described. (W.H.K.)

21404 RADIATION MONITORING SYSTEM UTILIZING PSEUDO-COINCIDENCE TECHNIQUES. Kurz, Rainer (to Laboratorium Dr. Berthold, Wildbad). U. S. Patent 3,546,457. 8 Dec 1970. Priority date 8 Jun 1966, Germany.

A radiation monitoring system with two input channels and pseudo-coincidence circuitry comprises means for delaying the pulses which arrive first in one input channel and means for stretching the other pulses in the other input channel whereon both channels are fed to an instrument forming the pseudo-coincidence. (auth)

XUM

21405 SOME PROPERTIES OF GM COUNTERS FILLED WITH $CO_2 + C_2H_5I$. Renk, H.; Chrapan, J.; Kopiczynski, T. (Technical Univ., Danzig). Acta Fac. Rerum Natur. Univ. Comenianae, Phys.; No. 9, 77-81(1969). (In Slovak).

The design and performance of a GM counter is given: The diameter of the brass cathode is 32 mm, the anode is formed by a tungsten wire 0.08 mm thick, and the active length is 300 mm. The counter is filled with CO_2 at a pressure of 522 torr and with C_2H_5I at a partial pressure of 27 torr. The plateau slope is 4 to 6% per 100 V between 300 and 500 V. A block diagram of a circuit for measurement of delayed pulses is also shown. At a counting efficiency of 93% and an ion mobility of 1.13 $cm^2/s.V$, good agreement was found between the theoretical curve and results of measurement. (NSA of Czech.)

21406 MEASUREMENT OF EXTREMELY LOW ^{14}C ACTIVITIES WITH GM COUNTERS. Renk, H.; Chrapan, J. Acta Fac. Rerum Natur. Univ. Comenianae, Phys.; No. 9, 61-75(1969). (In Slovak).

The use of GM counters for measurement of extremely low carbon activities is discussed. The general rules to be observed in such measurements are briefly considered. A brief description is given of screen wall counters frequently used to measure low activities. Gas-filled counters are more suitable since sample contamination is avoided. Characteristics of CO_2-filled GM counters are tabulated. Also given are characteristics and graphs on GM counters filled with a mixture of $CO_2 + CS_2$ and of $CO_2 + C_6H_{14}$. (NSA of Czech.)

21407 TL-NEUTRON DOSIMETER (10 Sep 1970) (Engineering Materials). (Savannah River Operations Office, AEC). CAPE-2058).

3 drawings.

A neutron dosimeter for measuring personnel exposure utilizes thermoluminescent LiF as the detecting element. The LiF is arranged in a polyethylene .997 in. hemisphere which is shielded with 0.003 in. thick Cd. The dosimeter response depends on the neutrons reflected from the body, therefore the dosimeter is worn on the belt to provide a more reproducible geometry than is obtainable with a clip-mounted version. The instrument is small and not heavy. It provides γ discrimination dose-rate independence, acceptable response over a wide-range spectrum, does not fade, and is easy to evaluate with conventional equipment. (F.S.)

21408 CRITICALITY ALARM SYSTEM (21 Aug 1970) (Engineering Materials). (Dow Chemical Co., Golden, Colo.). (CAPE-2060).

14 drawings.

A nuclear criticality alarm system used for detecting high levels of neutron radiation, incorporates a sampling system which reduces the chances of accidental alarm from noise pulses. Two detector units are required to sense the neutron flux before a general alarm is given. Detectors employ a thermal neutron reaction with ^6Li to produce α particles. Medium speed counting capability is provided at minimum cost. (For details see TID-4100, Suppl. 63) (F.S.)

21409 METHOD OF MAKING A NUCLEAR PARTICLE DETECTOR. Mueleman, Johannes (to U. S. Phillips Corp.). U. S. Patent 3,511,722. 12 May 1970. Priority date 24 Sep 1965, France.

A method of manufacturing a nuclear particle detector comprising a dE/dx detector and an E detector united in a common semiconductive wafer is described. On a substrate of one type conductivity is provided, preferably by diffusion, a surface layer of the opposite type conductivity to form the E detector, on the surface of which is epitaxially grown a thin high resistance semiconductive layer into or on which is provided a second region of the original one type conductivity to form a dE/dx detector. The advantages include simplified manufacture plus reduced series resistances and depletion regions for both of the detectors of adequate thickness. (auth)

21410 ADVANTAGES OF 1,1',4,4'-TETRAPHENYLBUTA-1,3-DIENE IN THE PREPARATION OF SOME SCINTILLATORS. Golutvina, I. G.; Dobrovol'skaya, A.; Zhil'tsova, L. Ya.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 770-1(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 122-3(May-Jun 1970).

Plastic scintillators containing this solute are convenient for making nonstandard items such as fibers, films, plates, gas-converters, etc. They have high radiation resistance, wide operating temperature limits, and very stable scintillation characteristics. (auth)

21411 COLLECTION OF CHARGE IN γ-RAY COUNTERS MADE OF LITHIUM-DRIFTED GERMANIUM. Novikov, S. R.; Novogrudskii, B. V.; Pustovoit, A. K.; (and others). (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 4: 887-91(Dec 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 1039-45(Jun 1970).

The relationship between the effective value of the carrier lifetime (τ_{eff}) found from the charge collection in lithium-drifted germanium counters and the values of the lifetime determined by various methods in the initial material is analyzed. For most of the investigated crystals, the value of τ_{eff} is correlated with the 78°K value of the initial lifetime, which was either deduced from the short-circuit current of a diode prepared from the initial material and irradiated with γ-ray quanta, or measured by the injection–extraction method. (auth)

21412 SPATIAL RESOLUTION AND COUNT RATE CAPACITY OF A POSITRON CAMERA: SOME EXPERIMENTAL AND THEORETICAL CONSIDERATIONS. Kenny, Peter J. (Univ. of Miami, Florida). Int. J. Appl. Radiat. Isotop.; 22: 21-8(Jan 1971).

A positron camera consisting of two coaxially opposed scintillation cameras with $13\frac{3}{8} \times \frac{1}{2}$ in. NaI(Tl) crystals was used for some basic experimental measurements on the partition of count rate between the photopeak and non-photopeak parts of the energy spectrum and between the coincident and non-coincident fractions. The measurements were done with a point source in air and with a volume source in a scattering medium, and are expressed as percentages of the total count rate in one detector. A theoretical basis for the results of the point source measurement is presented and compared with the experimental data. Experimental data on spatial and spectral resolution of the detectors are also given. Some fundamental theoretical considerations on the count rate capacity of such a positron camera are presented based on the measured count rate partition, on the time constant of NaI(Tl) and on the resolving time of the electronic circuitry. The useful count rates which may be expected in a realistic in vivo application are discussed. (auth) (UK)

21413 AUTOMATIC SCANNING SYSTEM FOR RADIATION DOSE DISTRIBUTIONS. Etchells, S. H.; Clarkson, D. G. (Dept. Clinical Physics and Bio-Engineering, Glasgow). Phys. Med. Biol.; 16: 135-8(Jan 1971).

An electronically controlled electromechanical scanning system has been constructed that produces a complete set of transverse data derived from the output of two small (0.4 cm^3) ionization chambers. The movement of the main chamber is controlled by solid state logic circuits and stepping motors to follow a programmed path as it moves over the X Y plane containing the beam axis. After amplification, the electrical output of the chamber, 1_M, is compared with that of a plane reference chamber, 1_R, which is free to move along an axis parallel to that of the main ionization chamber, but has fixed X and Z coordinates. Computation of the ratio $1_M/1_R$ is done by a solid state radiometer, and the data output is available in two forms: as a continuous analog signal, and a digital print-out from a commercial digital voltmeter, in a form suitable for input to a computer. (UK)

21414 ELECTRON ENERGY CALIBRATION OF A 45 MeV BETATRON USING THE CHERENKOV EFFECT. von Arx, A.; Kuphal, K.; Sempert, M. (Brown Boveri and Cie AG, Baden, Switzerland). Stud. Biophys.; 23: 51-9(1970). (In German).

By measuring the threshold of Cherenkov radiation in a gas the electron energy of accelerators for radiation therapy can be calibrated since it is possible to evaluate the refraction coefficient, n, of the gas with sufficient accuracy using pressure and temperature measurements of the gas. Different values of n for different electron energies can be obtained by varying the pressure of a gas or the proportions of two gases in a tube. A circuit for light measurement with two detectors is described in which the effect of accelerator leakage radiation is eliminated. The determination of electron energy spectra is also possible. (auth)

21415 CALCULATION OF THE IMAGE ERRORS IN SCINTIGRAPHY. Habermehl, A.; Graul, E. H. (Philipps-Univ., Marburg, Ger.). Stud. Biophys.; 23: 199-206(1970). (In German).

Because of the limited resolution power of technical systems, errors arise in imaging distributions of radioactivity by a scanner on a scintigram. The image can be represented by a convolution integral between the given object-function and the scanner- or collimator-function or as a linear transformation of the object-function. Computation of the mathematical expressions shows the greatness of the errors and their importance in clinical practice. The formulation as convolution can be the starting point of procedures for image restoration by deconvolution. (auth)

21416 IMPROVED TOLUENE-BASE SCINTILLATOR FOR ESTIMATING RADIOACTIVITY IN AQUEOUS SAMPLES. Shamoo,

Adil E. (City Univ., New York). Anal. Biochem.: 39: 311-18 (Feb 1971).

The counting efficiency of liquid scintillators containing toluene as the solvent of a primary solute or activator and for a secondary solute or spectrum shifter is improved, particularly in the presence of water, for example, when the isotope to be detected is in aqueous solution, by adding to the liquid scintillator a hygroscopic substance which is soluble in toluene in an amount sufficient to absorb the water that is present. Such hygroscopic additive is preferably cellulosic and may be selected from the group consisting of cellulose, carboxymethylcellulose, cellulose phosphate, diethylaminoethylcellulose, benzyldiethylaminoethylcellulose, and epichlorohydrintriethanolaminecellulose. (auth)

21417 PREPARATION OF LARGE PLASTIC FILMS FOR PROPORTIONAL COUNTER WINDOWS. Grader, R. J.; Hill, R. W.; McGoff, C. W.; Salmi, D. S.; Stoering, J. P. (Univ. of California, Livermore). Rev. Sci. Instrum.: 42: 465-7(Apr 1971).

The preparation of thin and uniform plastic films for rocket-borne x-ray proportional counters is described. The technique has produced entrance windows of 60 $\mu g/cm^2$ thickness and 700 cm^2 in area. (auth)

21418 CORRECTION OF THE EXIT OUTPUT VOLTAGE OF A RATEMETER BY MEANS OF AN ANALOGUE CIRCUIT. Lange, D. (Univ., Heidelberg). Nucl.-Med.: 9: 375-84(31 Dec 1970). (In German).

Using an analog circuit, a variable portion of the output voltage of a ratemeter is subtracted from the output voltage of another ratemeter. This technique could be used in simultaneous double-tracer studies or for background subtraction. It is demonstrated by calculations and measurement examples that even if both voltages which are subtracted from each other, show random variations no appreciable deterioration of the thus corrected output voltage occurs. The frequency limit of the circuit permits partial subtraction of pulses coming from inorganic scintillators. (auth)

21419 TRANSFER-STATE POPULATION IN LIQUID SCINTILLATORS. Levin, E. (York Coll., New York); Furst, M.; Kallmann, H. J. Chem. Phys.; 54: 2580-3(15 Mar 1971).

A parameter, n_e, which represents the number of primary excited solvent molecules from which energy can be transferred to the scintillator, may be determined by studying fluorescence under high-energy and ultraviolet excitations. The temperature variation of n_e was measured over a range of 200°C and was found to be considerable for high-energy excitation. This variation is attributed to changes in intermolecular coupling. Following ideas of Magee and Platzman, the (bulk modulus)$^{-1}$ was assumed as a measure of this coupling. The experimental results show good agreement with the theory. Study of different solutes reveals that n_e is made up of two factors only one of which is temperature dependent. (auth)

21420 SPECTROMETRY OF BREMSSTRAHLUNG WITH SEMICONDUCTORS. POSSIBILITIES AND LIMITS. Drexler, G. (Gesellschaft fuer Strahlenforschung mbH, Neuherberg, Ger.). Stud. Biophys.; 23: 233-42(1970). (In German).

The method of bremsstrahlung measurement by means of semiconductors is discussed and the lower and upper energy limit for a correction free determination of the spectral distribution is indicated. The experimental setup and typical spectra are shown. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 22972.

21421 (NBS-TN-541) PRELIMINARY STUDY ON THE CHARACTERISTICS AND DESIGN PARAMETERS FOR A MOESSBAUER RESONANT DETECTOR. Spijkerman, J. J.; Travis, J. C.; Pella, P. A.; DeVoe, J. R. (National Bureau of Standards, Washington, D. C.). Jan 1971. 65p. GPO $0.65.

Progress in the design and fabrication of a resonant detector for Moessbauer spectroscopy is described. This report begins with a review of all of the methods of detection for this spectroscopy and describes the expected advantages of the resonant detector. If one uses conversion electron detection, considerable enhancement in signal to noise ratio and decrease in linewidth may be realized. Efforts to produce an iron bearing resonant material are described. (auth)

21422 METALLURGICAL METHOD FOR PREPARING HIGHLY ACTIVE SOURCES FOR MOESSBAUER SPECTROSCOPY OF IRON. Godovikov, S. K.; Kuz'min, R. N. (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 936-7(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 261-2(May-Jun 1970).

A method of preparing Moessbauer ^{57}Co sources based on alloys having a high cobalt content, which permits a sharp increase in the specific activity in comparison with the present admixture method, is described. (auth)

21423 TELESCOPIC FAST-NEUTRON SPECTROMETER WITH AN IMPROVED EFFICIENCY. Tyke, Ya.; Fryshchin, B.; Sikora, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 718-20(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 77-9(May-Jun 1970).

A new method is described for improving the efficiency of a telescopic fast-neutron spectrometer. Two radiators are placed in the telescope: a polyethylene radiator and a deuterium-polyethylene radiator, and the spectra of the recoil protons and deuterons are measured simultaneously. The count efficiency of such a spectrometer is twice as high as the efficiency of a spectrometer with one polyethylene radiator having the same resolution. The method was checked for measurements of neutron spectra from the $^7Li(d,n)$ reaction. (auth)

21424 STABILIZATION SYSTEMS OF A GAMMA-RAY SPECTROMETER. Sabo, L.; Sotnikov, S. K.; Danelyan, L. S.; (and others) (Central Inst. of Physical Research, Budapest. Atomic Energy Inst., Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 708-4(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 68-74(May-Jun 1970).

The systems for stabilizing the gain and threshold of the measurement channel of a spectrometer are described in which the pulse amplitudes are compared with the amplitudes of these same pulses after they have passed through the stabilized channel. In one of these systems the reference signal is produced by a semiconductor (electroluminescent) diode, while in the other system it is produced by a generator of twinned reference pulses. During physical measurements the stability of the position of spectral lines, referred to the energies of the lines, was at worst ±0.35%. (auth)

21425 SCINTILLATION NaI(Tl) GAMMA SPECTROMETER WITH A RING GUARD CRYSTAL HAVING THE DIMENSIONS 200 x 380 mm. Danelyan, L. S.; Kardon, B.; Kishsh, D.; (and others) (Atomic Energy Inst., Moscow. Central Inst. of Physical Research, Budapest). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 703-7(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 63-7(May-Jun 1970).

A NaI(Tl) gamma spectrometer with a ring guard crystal 200 × 300 mm, which is used to measure gamma-ray spectra at neutron resonances, is described. The electronic circuit allows measurements to be carried out in an anticoincidence mode, a coincidence mode with a 0.51-MeV quantum, and in a paired-spectrometer mode. Two systems are used to stabilize the gain and the threshold of the analyzing-crystal channel. A method is given for processing complex spectra on the basis of resolving them into individual components. (auth)

21426 USE OF A SEMICONDUCTOR ALPHA SPECTROMETER TO ANALYZE PREPARATIONS CONTAINING CALIFORNIUM. Rodionov, Yu. F. (Atomic Energy Inst., Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 700-2(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 61-3(May-Jun 1970).

A method for determining the relative ^{252}Cf concentration in samples whose radioactive radiation is caused to a considerable degree by spurious impurities is described. A block diagram of the instrument is presented and then used to determine the spectrum of fragments from spontaneous fission of ^{252}Cf. (auth)

High Energy Physics Instrumentation

21427 THYRISTOR HIGH-VOLTAGE PULSE GENERATORS. Artem'ev, V. A.; Voronova, N. G.; Knyazev, V. M. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 817-18(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 162-3(May-Jun 1970).

Thyristor high-voltage pulse generators for triggering spark chambers are described. The generators use KU201L thyristors and produce isolated pulses having for the respective generators the following parameters: pulse voltage, 4 and 5 kV; pulse current, 100 and 50 A; rise time 100 nsec; delay from moment of application of triggering pulse, 80 and 400 nsec. (auth)

21428 ELEMENTARY PARTICLE TRACK COORDINATE MEASUREMENTS WITH A LINEAR SCANISTOR. Zheltovskii, G. A.; Gos'kov, P. I. (Tomsk Inst. of Radio Electronics and Electronic Tech., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 798-802(May-Jun 1970).

XUM

Translated from Prib. Tekh. Eksp.; No. 3, 146-50(May-Jun 1970).

The use of a scanistor type sensor for measuring bubble and spark chamber track coordinates is examined. A block diagram of the automatic device, functional diagrams of its basic units, an analysis of errors in track measurement and experimental results are given. (auth)

21429 THRESHOLD CHERENKOV COUNTER OF HIGH RESOLUTION. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 764-6(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 117-19(May-Jun 1970).

A gas-type threshold Cherenkov counter with a velocity resolution of $\delta = 6.5 \cdot 10^{-6}$ and a length of 5 m is described. On summing the signals from two counters a resolution of $\delta = 3.6 \cdot 10^{-6}$ is achieved. The particle-recording efficiency on the count plateau is over 0.9999994. The probability of recording particles in the region below the threshold of Cherenkov radiation is $\gtrsim 3 \cdot 10^{-4}$. (auth)

21430 DEPENDENCE OF THE BRIGHTNESS OF A SPARK ON IONIZATION. Bolotov, V. N.; Bydanov, G. A.; Devisheva, M. N.; (and others). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 761-3(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 114-16(May-Jun 1970).

The operating conditions of wide-gap spark chambers were studied over a wide range of ionization losses ($1 \leq I/I_0 \leq 15$) with gas pressures of 0.1 and 1 atm in the chamber. It was found that: 1) The character of the H (I/I_0) relationship was the same at both pressures; 2) the increase in spark brightness on passing from the lowest to the highest degree of ionization was largely determined by the operating conditions of the chamber; this change was the greater, the smaller the brightness at $I/I_0 = 1$; and 3) the brightness distribution of the sparks for particles of the same energy coincided with the Landau distribution. (auth)

21431 CHARACTERISTICS OF A POLYURETHANE FOAM STREAMER CHAMBER. Alihanov, A. I.; Ainutdinov, M. S.; Artem'ev, V. A.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 759-60(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 113-14(May-Jun 1970).

Tests have been made of a two-electrode polyurethane foam streamer chamber having side walls of PPU-305 polyurethane foam (sp. gr. 0.14 g/cm^3; dielectric constant 1.08 at 10^6 Hz). PPU-305 has the following advantages over other materials: 1) The chamber may be made as a solid casting without any glued joints which might fracture on account of a difference between the coefficients of expansion of the glue and the walls of the chamber; 2) there is no distortion of the electric field at the walls, as such distortions are proportional to the difference between the dielectric constants of the chamber wall and the working gas; and 3) the low specific gravity and dielectric constant of the PPU-305 enable targets of this material to be introduced into working space. Stable tracks have been obtained, localized to an accuracy of 0.20 ± 0.02 mm. They have been scrutinized for distortion in the vicinity of a model target. The effect of CO_2 on the operation of the chamber has been determined. (auth)

21432 ACOUSTIC SPARK CHAMBER USING SONIC WAVE REFLECTION. Kurochkin, A. V.; Yurkin, Yu. T. (Moscow Engineering Physics Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 757-8(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 111-12(May-Jun 1970).

A chamber having sonic location of sparks in accordance with the reflected sonic waves, which permits the attainment of minimum chamber dimensions for a given working region is described. For a simple design of the chamber and the capacitance microphones, a spark location accuracy of 0.2 mm is achieved. The effect of spark slope on the method's accuracy is verified, and the effect of the spark's light on the properties of the capacitance microphones is studied. (auth)

21433 ACCOUNTING FOR BRAKING AND OBLIQUE ANGULARITY WHEN USING A REPROJECTOR TO PROCESS THE TRACKS OF LOW-ENERGY PARTICLES IN A BUBBLE CHAMBER. Sherman, S. G. (Ioffe Inst. of Physics and Tech., Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 755-6 (May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 109-10(May-Jun 1970).

The results of using a stereo reprojector for processing the photographs obtained in a hydrogen bubble chamber are described. A method for eliminating systematic measurement errors is discussed. (auth)

21434 OPERATION OF A 34-cm FREON BUBBLE CHAMBER IN THE PHOTON BEAM OF A 2-GeV ELECTRON LINEAR ACCELERATOR. Tonapetyan, S. G.; Goncharov, N. V.; Khvorostyan, V. M.; Konovalov, O. G.; Derebchinskii, A. I. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 751-4(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 106-9(May-Jun 1970).

A 34-cm freon bubble chamber provided with a tube for the beam, working in the photon beam of a 2-GeV linear electron accelerator, is described. The chamber containing freon liquid is capable of operating in such a mode that the tracks made by particles with a minimum ionization have a very low bubble density, or are even completely invisible. On working in this mode, it is easy to identify the π^- mesons stopped in the chamber when studying the photo-generation of charged π^- mesons in nucleons and nuclei. (auth)

21435 MAGNET OF THE ITEP TWO-METER LIQUID. Aleshin, Yu. D.; Kats, M. M.; Kiselevich, I. L.; (and others) (Inst. for Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 747-50(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 103-5(May-Jun 1970).

The construction and characteristics of the magnet in the ITÉP two-meter liquid hydrogen bubble chamber are described. With a current of 6 kA (4.5 MW required power) in the operating chamber, the field is 21.7 kOe with nonuniformity not exceeding ±6%. (auth)

21436 ITEP TWO-METER LIQUID-HYDROGEN BUBBLE CHAMBER. Aleshin, Yu. D.; Arutyunyants, G. A.; Verebryusov, V. S.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 744-6(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 100-2(May-Jun 1970).

The design and basic operating characteristics of a liquid-hydrogen bubble chamber with an effective volume of $205 \times 60 \times 41$ cm^3 and a magnetic field of 21.7 kOe are described. (auth)

21437 MINIATURE CHERENKOV SHOWER SPECTROMETER. Varfolomeev, A. A.; Glebov, V. I.; Denisov, E. I.; Korolevich, Yu. B. (Inst. of Atomic Energy, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 735-7(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 92-5(May-Jun 1970).

A Cherenkov shower spectrometer incorporating a KRS-6 (TlCl + TlBr) crystal as radiator is described. The radiator occupies a volume of 0.9 liter and is 14 radiation lengths in thickness. The calibration characteristic, obtained with an electron beam with energies in the range 200 to 1200 MeV, is linear. The energy resolutions corresponding to the limiting energies are 27% and 18%, respectively. (auth)

21438 MAGNETIC MONOPOLE DETECTOR UTILIZING SUPERCONDUCTING ELEMENTS. Alvarez, Luis W.; Antuna, Maurilio Jr.; Byrns, Roscoe A.; (and others) (Univ. of California, Berkeley). Rev. Sci. Instrum; 42: 326-30(Mar 1971).

An electromagnetic detector has been built to extend the search for magnetic monopoles to the lunar sample returned during the Apollo missions. It is sensitive to the minimum magnetic charge allowed by Dirac's theory and permits analysis of a sample without changing any of its properties. The apparatus consists of a superconducting niobium sensing coil with a core at room temperature, shorted by a superconducting mechanical switch and protected against the effects of variable ambient magnetic field by an adequate shield made of superconducting lead. Characteristic features, performance, and sample containers are described. (auth)

21439 BUBBLE CHAMBERS. Tenner, A. G. (Univ., Amsterdam). pp 49-55 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Recent measurements on bubble chamber liquids are surveyed. A model calculation is made to explain the nucleation in hydrogen. The behavior of heavier liquids is discussed. (auth) (UK)

21440 RESOLUTION OF HIGH ENERGY EXTREMELY HEAVY COSMIC RAYS IN PLASTIC DETECTORS. O'Sullivan, D.; Kobetich, E. J.; Shirk, E. K.; Price, P. B. (Univ. of California, Berkeley). Contract AT(04-3)-34. Phys. Lett.; 34B: 49-50(18 Jan 1971).

Measurements of etch pit length in Lexan plastic sheets along

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the trajectory of a nucleus ($Z \approx 78$, $E > 3$ GeV/nucleon) that penetrated a 10.2 g/cm^2 stack without interacting attest to the reliability of the response of Lexan to highly relativistic extremely heavy nuclei. For events whose velocity is known to be >0.9 c, it is possible to identify nuclei with $Z \geq 70$ using only a few sheets of Lexan. (auth)

21441 APERTURE OF COUNTER TELESCOPES FOR PARALLEL PAIRS OF PARTICLES. Barton, J. C. (Northern Polytechnic, London). J. Phys., A (London); 4: L18-19(Jan 1971).

The difference between the aperture of a counter telescope for single particles and for pairs is explained. Expressions are given for both apertures and the significance of the difference for the interpretation of underground data is indicated. (auth) (UK)

21442 DETECTOR OF CHARGE AND DIRECTION FOR REGISTRATION OF COSMIC PARTICLES OF HIGH ENERGY ON SATELLITE PROTON-3. Grigorov, N. L.; Madeev, M. O.; Rapoport, I. D.; Savenko, I. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: 549-53(Sep-Oct 1970). (In Russian).

A detector for recording the charge and direction of particles in high-energy cosmic emission with the geometric factor of $\Gamma \sim 300$ cm^2 strad was described. The detector was installed on the satellite Proton-3 for recording the flux and chemical composition of cosmic radiation in the charge range from $Z \geq 1$ to $Z \sim 50$. (R.V.J.)

Radiation Dosimeters

Refer also to abstracts 21706, 21716, 21717, and 21720.

21443 (EUR-4540) MODERATION OF FAST NEUTRONS IN POLYETHYLENE AND THEIR USE IN NEUTRON DOSIMETRY. Rohloff, F.; Heinzelmann, M. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). 22 Jul 1970. 172p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 16,50.

An improvement in neutron field measurement (fluence and equivalent dose power) by means of moderator balls is suggested. The spatial distribution of the flux density of the thermal neutrons in the moderator is used for the measurement. To arrive at the measured value, use is made of both the counting rates at the center of the various balls, and also the counting rates at different points in a single ball. By this means a compact counter is produced of which the indications are independent of direction. Lithium fluoride thermoluminescent dosimeters were used. (auth)

21444 (RD/B/N-1830) CALORIMETRIC DOSIMETRY IN THE B.N.L. γ-FACILITY. Sach, R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec. 1970. 11p. Dep. NTIS (U. S. Sales Only).

The dose rate at various sample irradiation positions in the BNL γ-facility was measured with a graphite calorimeter. The measured dose rates are in good agreement with measurements made by the Glucose and Fricke dosimeters. (auth) (UK)

21445 (RD/B/N-1872) THE VARIATION IN SENSITIVITY OF TLD LiF EXTRUDED RODS WHEN ANNEALED AT 500°C. Tobias, A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1971. 13p. Dep. NTIS (U. S. Sales Only).

A study of the variation of the sensitivities of individual TLD-LiF dosimeter rods was carried out to assess their use for accurate measurements. It was found that the optimum annealing temperature for TLD-LiF powder of 500°C when used with TLD LiF rods caused a reduction in sensitivity which could not be removed by annealing at 400°C. Annealing the rods at 400°C produced only a few percent variation in sensitivity from the mean value. (auth) (UK)

21446 (RT/FI-(70)37) DOSIMETRY APPLICATIONS OF THERMALLY STIMULATED ELECTRON EMISSION. Rotondi, E.; Bordoni, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 31 Jul 1970. 35p. (In Italian). Dep. NTIS (U. S. Sales Only).

The use of the TSEE properties of irradiated material for dosimetry is discussed. Ceramic beryllium oxide and calcium sulfate (pure and doped with samarium, manganese, and lead) were studied. The activators in calcium sulfate were found to decrease the exoelectron yield. Properties of beryllium oxide for use as a personnel dosimeter are discussed. (auth)

21447 (TID-24270, pp C.37-40) THERMOLUMINESCENT DOSIMETRY. Hall, Roscoe M. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

From Tropical rain forest.

The procedures used to estimate gamma-radiation dosage with lithium fluoride capsules in the rain forest at El Verde, Puerto Rico, were tested. Glow curves were made of fluorescence during reading, the loss of response due to storage, and losses due to exposure to light. A second glow peak with emission between 270 and 400°C was used to assay very high dosages. (auth)

21448 RADIATION MEASUREMENT BY CHEMICAL METHODS. Klein, Nathan; Sasse, Ronald A. (Army Aberdeen Research and Development Center, Aberdeen Proving Ground, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 268-71(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A technique, based on a variation of kinetic spectroscopy, is presented to measure radiation dose and dose rate from pulsed sources. The hydrated electron, produced by ionizing radiation in aqueous media, has an optical absorption in the visible region of the spectrum. This absorption is used to follow the radiation pulse. This method has the intrinsic advantages of extremely high speed, low cost, and minimal calibration. A chemical system is described that will allow the dose and dose rate monitoring cell to be used repeatedly. The method described covers the range from 100 rad to 10 krad at dose rates as high as 2×10^{12} rad s^{-1}. Radiation pulses as short as 5ns have been resolved. (auth)

21449 THERMOLUMINESCENCE DOSIMETER. Nakajima, Toshiyuki (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo); 19: No. 4, 201-9(Apr 1970). (In Japanese).

The principle of thermoluminescence dosimetry is explained on the basis of Randall and Wilkins' model for thermoluminescence. Radiation characteristics are described including: (1) the requirement for illuminants and the kind of illuminants; (2) sensitivity and the relationship between the quantity of emission and dose; (3) accuracy and time-dependent variation; (4) dose dependence; and (5) energy dependence. Applications of thermoluminescence dosimeter are discussed including age determination, the dosimetry of internal exposure, absorbed dose measurement, LET measurement, and health-physical and medical applications. (Japan)

21450 MICRODOSIMETRIC MEASUREMENTS OF FAST NEUTRONS BY MEANS OF A TISSUE-EQUIVALENT PROPORTIONAL COUNTER OF 1 CM DIAMETER. Krueger, H.; Graul, E. H. (Philipps-Univ., Marburg, Ger.). Stud. Biophys.; 23: 27-36(1970). (In German).

For neutron-therapeutical investigations it is important to know not only depth-dose curves but also the changes of radiation quality in the human body. A ball-shaped tissue-equivalent proportional counter of 1 cm diameter, which was built for this purpose, is briefly described. LET-spectra as well as the spectra of "local specific energy" and their depth-dependent changes were inferred from the microdosimetric measurements in a tissue-equivalent trunk phantom made with the proportional counter, and discussed. (auth)

21451 DOSIMETRIC PROBLEMS OF BREMSSTRAHLUNG WITHIN THE GeV RANGE. Zywietz, Friedrich (Univ., Hamburg). Stud. Biophys.; 23: 61-8(1970). (In German).

An experimental determination of the absorbed dose of high-energy bremsstrahlung ($E_{max} = 6200$ MeV) was undertaken using the ferrous sulfate dosimeter. The irradiation technique, the beam properties and the dosimetry are described. From the irradiation of the ferrous sulfate solution in a 6.2 GeV photon beam and the data of the time integrated quantum flux by a quantameter, a dose-flux relation results of 0.73×10^{-7} rad/Qeff cm^{-2}. For the calculation of the absorbed dose, a G-value of 15.6 was used. The development of the electromagnetic cascade in a water phantom leads to an increase in dose-rate with depth and is measured with the ferrous sulfate dosimeter for various energies. (auth)

21452 CALIBRATION OF CAVITY IONIZATION CHAMBERS. Fraenz, H. (Physikalisch-Technische Bundesanstalt, Brunswick). Phys. Med. Biol.; 16: 57-66(Jan 1971).

A method is described for the calibration of a commercial thimble ionization chamber, intended for use as a Bragg-Gray cavity chamber at high photon energies, in such a way that the reading of the instrument can be converted into the "ion dose" in the air volume of the chamber, i.e. the quotient of the ion charge and the mass of air in that volume. The factor for this conversion is independent of the photon energy. The measurements of a correction factor are described. The theoretical ex-

pression for the energy dependent conversion factor, in calculating the absorbed dose in water from the reading of the dosemeter when the chamber is used in a water phantom, was compared with calculations of the other authors. (auth) (UK)

21453 COMPARISON OF IONIZATION, FERROUS SULPHATE, AND THERMOLUMINESCENCE DOSIMETRY OF MEGAVOLTAGE PHOTONS. Law, J. (Royal Infirmary, Edinburgh); Naylor, G. P. Phys. Med. Biol.; 16: 67-75(Jan 1971).

For ^{60}Co γ-radiation and 8, 15 and 33 MeV x-rays, dose measurements were made and compared using (a) a calibrated Farmer–Baldwin dosemeter and C_λ values recommended by I.C.R.U. and (b) $FeSO_4$ solution and G-values recommended by I.C.R.U. Differences between the results were within 5%, and increased with increasing photon energy, $FeSO_4$ results always being the greater. The relative response of LiF TLD powder to these radiations was also compared with ionization measurements. On the assumption that the C_λ values were substantially correct, and that for ^{60}Co radiation G = 15.5, the data gave $FeSO_4$ G-values of 16.1 ± 0.2 at 8 MeV, 15.9 ± 0.2 at 15 MeV and 16.3 ± 0.2 at 33 MeV. These were in good agreement with the few literature values for photons in this energy region, but were not consistent for high energy electrons. (auth) (UK)

21454 COMPARISONS OF THE RESPONSE OF FARMER–BALDWIN DOSEMETERS TO MEGAVOLTAGE X-RAYS. Day, M. J.; Frost, A. P.; Habbani, F. I.; (and others) (Newcastle General Hospital, Eng.). Phys. Med. Biol.; 16: 144-9(Jan 1971).

Eight Farmer–Baldwin dosemeters were compared, using ^{60}Co γ rays, 15 MeV x rays and 33 MeV x rays. Two other chambers of similar dimensions were also used with aluminum and carbon walls. Subsequently each chamber was compared with a standard graphite chamber using 2 MeV x rays. A graph is given of the calibration factors of nine of the ionization chambers over the range 0.3 mm Al HVT (0.0075 mm Cu) to 2 MeV (12mm Cu), expressed relative to their values at 2 MeV. The results support the theory that essentially the same C_λ values can be applied to chambers of any type less than 1 cm diameter and made of materials of low atomic number. (UK)

21455 D.C. POWER SUPPLY FOR THE FARMER SECONDARY STANDARD X-RAY DOSEMETER. Tetenes, P. J. (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Phys. Med. Biol.; 16: 139-40(Jan 1971)

A circuit diagram is given for the conversion of the Farmer dosemeter from battery to an alternating current supply. The 1.5 volt and 190 volt D.C. supplies are unregulated, but the 18 volt D.C. line is regulated by a Zener diode. The calibration and reliability are unchanged, but the lack of regulation makes the instrument sensitive to line voltage fluctuations. (UK)

21456 SEMI-AUTOMATIC TLD READER. Kartha, M.; MacDonald, J. C. F. (Ohio State Univ., Columbus). Phys. Med. Biol.; 16: 141-3(Jan 1971).

A semiautomatic instrument capable of reading 23 thermoluminescent dosimeters in sequence is described. Each TLD is carried on a planchet mounted in the periphery of a step-driven turntable. The planchets are electrically heated to 300°C when they come under the photomultiplier. The rest of the instrumentation is available commercially and output is obtained on an electric typewriter. The 23 TLDS are measured in approximately 15 minutes. (UK)

21457 STEADY-STATE DIFFERENTIAL CALORIMETER FOR REACTOR RADIATION DOSIMETRY. Sato, Takashi; Ono, Koichi; Yoneda, Kenji; Shibata, Toshikazu (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 130-8(1970).

A steady-state differential calorimeter of simple structure and small size for absolute determination of the total energy contribution rate without perturbing the reactor radiation field has been designed: The samples for energy absorption were lead, polyethylene, pure aluminum and aluminum-containing lithum fluoride powder which were sensitive to fast neutrons, thermal neutrons, and gamma-rays. The components of the energy contribution rates by gamma-rays and neutrons were calculated. The experimental work has been carried out in the slant exposure tube of the Kyoto University Reactor, KUR, at 5 MW. The total energy contribution rate was 237 mW/g to 944 mW/g for various materials at 2.0×10^{13} nv thermal neutron flux. The contribution of energy deposition rate depends on the distance from the core and the kind of materials. (auth)

Radiometric Instruments

Refer also to abstracts 21192, 21193, and 21240.

21458 NEW METHOD OF DETERMINING THE DEW POINT BY SCATTERING OF β RAYS. Kobayashi, Hisanobu (Saitama Univ., Japan). Rev. Sci. Instrum; 42: 397-8(Mar 1971).

The principle employed in the dew point hygrometer is that the β-ray scattering by the metal surface decreases when the surface is covered by dew. This decrease of β-ray scattering is caused by the decrease of the effective atomic number of the scattering surface material because metals usually have large atomic numbers and dews consist of elements which have small atomic numbers. (W.H.K.)

21459 SIGNATURE COMPARISON TECHNIQUE FOR RAPID ALLOY SORTING WITH A RADIOISOTOPE EXCITED X-RAY ANALYZER. Sellers, Bach; Brinkerhoff, Joris (Panametrics, Inc., Waltham, Mass.). Mater. Res. Stand.; 10: No. 11, 16-18 (Nov 1970).

A new operational technique for rapid identification of metal alloys has been developed. Unlike standard x-ray analysis procedures requiring accurate quantitative assay of specific elements to effect the identification, the method utilizes a signature comparison technique involving a number of known standards. An inherent feature of the technique is that a set of two numbers is generated for each element which is characteristic of a specific alloy. Use of these two numbers as a dual entry signature on a plot utilizes the fact that the fluorescent x-ray emission from a particular characteristic element in the alloy not only depends on the concentration of that element but also is related to the character of the matrix material itself. By using more than one characteristic element as the basis for identification, additional sets of numbers are generated which, taken together, become positively indicative of a specific alloy. Results are presented which were obtained with a portable analyzer that uses a radioisotope source to excite fluorescent x rays in the alloy. The instrumentation retains the principal advantage of x-ray inspection, that is, it is nondestructive and, in addition, inexpensive, fast, and easy to use. Also, little or no specimen preparation is required. Rough castings as well as rod and bar stock can be tested if a reasonably smooth surface of several square centimeters area is available. Specific successful applications reported include identification of nickel- and aluminum-base alloys. (auth)

21460 INVESTIGATION OF THE POSSIBILITY OF DETERMINATION OF THE EMULSION THICKNESS OF PHOTOGRAPHIC FILMS USING THE NEUTRON ACTIVATION METHOD. Abrams, I. A.; Birze, M. R.; Breslav, V. I.; Pelekis, L. L.; Taure, I. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 4, 31-6(1970). (In Russian).

The neutron activation characteristics of the components of photographic emulsion and films are investigated. The principal induced activity is due to the ^{110}Ag. The thickness of the emulsion can thus be determined by the activity of ^{110}Ag. The neutron activation method can be used in laboratory conditions for measuring the emulsion thickness of photographic films. The neutron flux of the source must be $\Phi \geq 1 \times 10^8$ n per sec. (auth)

21461 RECENT ADVANCES IN HIGH-SPEED X-RAY THICKNESS GAGING OF STEEL STRIP. Howard, Roland M. (Jones and Laughlin Steel Corp., Pittsburgh). ISA (Instrum. Soc. Amer.) Trans.; 9: 348-54(1970).

With the high speeds at which steel strip is manufactured, it is becoming increasingly important to safeguard the customers' needs for closer control of thickness. Recent advances in x-ray thickness gaging technology have produced a series of reliable, high performance systems capable of measuring small, rapid variations at production speeds. Improved circuitry and more intense x-ray beams have permitted low-noise, high-performance gages which can give the detailed product knowledge needed today. A dual hot strip mill gaging system and an experimental gage are described. (auth)

21462 AREA MEASUREMENT METHOD WITH A RADIOACTIVE PREPARATION. Eggelsmann, H.; Rasp, W. PTB Mitt.; 80: 436-9(Dec 1970). (In German).

A method for the measurement of areas is described. The area to be measured is placed between a large-area radioactive source and a suitable radiation detector. The loss in counting rate at the detector caused by the absorbing material gives a direct measure for its area. The possible uncertainty in this method is discussed. It is shown that the uncertainty can be kept within a few per cent according to the experimental expenditure. (auth)

21463 CONTINUOUS ASH MONITORING AND COAL BLENDING PROCESSES. Crosland, R. (Mining Research and Development Establishment, Burton-on-Trent, Eng.); Hall, D. A.; Laverick, M. K. pp 179-200 of Mineral Processing and Extractive Metallurgy. /Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970).

From 9th Commonwealth Mining and Metallurgical Congress, London, England. See CONF-690561-(Vol.3).

Irradiation and bulk density ash monitors available and suitable for use in coal preparation plants are described including monitoring accuracy, range of application, costs, and system complexity. The development of one of each type of monitor is described covering both mechanical design and field trials with the results obtained. The application of the various ash monitoring devices to ash-controlled blending schemes is outlined and the particular advantages and disadvantages of each in respect to the method of blending being employed are given. The control schemes are considered, and the likely accuracies to be obtained from proportional, bulk density, and irradiation-based control systems or any combination of them given. Details of operational results obtained from differing systems both during commissioning trials and during normal pit running are given. Reference is made to the advantages of homogenization of widely varying ash components such as untreated small coal prior to controlled blending when irradiation-type monitors only are used. Future requirements and trends are appraised, as well as the available information on current developments. (UK)

Miscellaneous Instruments and Components

Refer also to abstracts 20932, 21172, 21173, 21216, 21300, 21313, 22089, 22935, and 23419.

21464 (APDA-252) LOOP EVALUATION OF THE APDA IN-LINE DETECTOR FOR HYDROGEN IN SODIUM. Coleman, J. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jun 1970. Contract AT(11-1)-865. 115p. Dep. NTIS.

The APDA-developed nickel-palladium catalytic hydrogen detector, based on the principle of catalytic oxidation of hydrogen to water, was evaluated in a dynamic system in the sodium technology loop. The detector was demonstrated to be a reliable, accurate, and sensitive means of monitoring the hydrogen concentration of a flowing sodium system. The linearity of response was demonstrated up to 3 ppM hydrogen; the sensitivity for a change in hydrogen concentration was 0.018 ppM. During the 4,000 hours of testing, no degradation of performance was observed. In addition to the stable performance of the detector coil, the sodium temperature control system, sweep gas system, hydrogen injector, and moisture monitor performed well. (auth)

21465 (BNWL-1491) MULTIELECTRODF ULTRASONIC TRANSDUCER TEST TECHNIQUES FOR RADIOISOTOPE ENCAPSULATION INSPECTION. Newman, Dennis R.; Steffens, Robert W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1971. Contract AT(45-1)-1830. 25p. Dep. NTIS.

Receiving ultrasonic transducers with 32 individual electrodes in a linear array on single piezoelectric chips have been fabricated. Linear densities of 32 electrodes per 4, 2.5, and 1.5 cm have been obtained on 5 MHz PZT-5. Electronic circuits for sampling and reading out the individual electrodes at rates of up to 2000 samples per second have been developed, along with the mechanical systems necessary for scanning and manipulating the transducers. The transducers have been used for rapidly testing radioisotope capsules for clad-to-core unbonds and core voids or porosities. (auth)

21466 (BNWL-CC-1793) HFT-1 DUAL BOND TESTER. Davis, T. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1968. Contract AT(45-1)-1830. 49p. Dep. NTIS.

The HFT-1 bond tester is a completely solid state, dual channel ultrasonic tester with a usable bandwidth of 0 to 60 MHz. It was developed to perform bond testing of the thin-clad N-Reactor fuel elements, wherein higher than normal ultrasonic test frequencies are required. Operation of the tester with 30 MHz ceramic transducers has provided a test capable of detecting clad-to-core unbonds and resolving back surface echoes for zirconium cladding thicknesses down to 0.006 inch. The tester secures stable transmitter performance from the avalanche transistor pulser, noted for its extremely fast rise time. A low-loss transmit pulse suppressor renders the ultrasonic receiver, composed of integrated circuit video amplifiers, compatible for pulse echo operation. Wideband gating and readout functions are achieved with voltage comparator and dual one-shot integrated circuits. The tester's rf signal gates are operable in either surface following or fixed delay modes. (auth)

21467 (CEA-Bib-194) MONOCHROMATIC X RAYS. Ballereau, Pierre (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jan 1971. 101p. (In French). Dep. NTIS (U. S. Sales Only).

Monochromatic x rays are finding an increased use in crystallographic studies and radiographic work. In Health Physics they are very useful for dosimeter calibration and are an essential tool for the calibration of film badges in which the blackening is strongly dependent on the incident photon energies between 10 and 300 keV. None of the monochromatization techniques proposed is perfect. Bibliographic research on the more pertinent articles and reports published on the matter was necessary. The references, covering the period up to July 1968, have been extracted from specialized reviews and reference periodicals, e.g., Nuclear Science Abstracts, Physics Abstracts, Electrical Electronic Abstracts, and Bulletin Signaletique du CNRS: Structure de la matiere. Also, the excellent Bibliography 3 of the International Union of Crystallography, Commission on Crystallographic Apparatus: "Methods of Obtaining Monochromatic X Rays and Neutrons" was a very important source of information. (auth) (France)

21468 (RT/FI-(70)22) TECHNIQUE FOR SELECTION OF TIME-CORRELATED EVENTS IN A SEQUENCE OF PULSES. Pacilio, N.; Ferrari, T.; Lorenzi, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 29 Apr 1970. 61p. (In Italian). Dep. NTIS (U. S. Sales Only).

The problem is faced of monitoring time-correlation within pulse sequences, which are partially random but also contain events linked by a correlation law. Structure, logic operation and applications are described of ad hoc devices (named correlation deterministic monitors) which are capable of spotting the most significant portions of pulse sequences and of initiating the storage of data only when a conspicuous fraction of correlated events is present. This type of monitor is an indispensable device for making some reactor-noise time-analysis techniques applicable in thermal and fast systems. (auth)

21469 DOUBLE ACOUSTIC NUCLEAR-NUCLEAR AND ELECTRON-NUCLEAR RESONANCE SPECTROMETER. Shamukov, N. A.; Golenishchev-Kutuzov, V. A. (Physical-Technical Inst., Kazan). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 850-2(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 186-8(May-Jun 1970).

A spectrometer for the study of double acoustic-magnetic nuclear-nuclear and electron-nuclear resonance which uses CW sound radiation at temperatures of 4.2 to 300°K is described. The sensitivity of the apparatus in measuring paramagnetic acoustic absorption is as high as 10^{-10} cm^{-1}. The NMR and EPR operating frequencies are 2 to 20 MHz, and 9600 MHz, respectively. Double acoustic resonance experiments were carried out in ruby (^{53}Cr = ^{27}Al, ^{27}Al = Cr^{3+}). (auth)

21470 SQUARE PULSE GENERATOR WITH PULSES OF LARGE AMPLITUDE AND OF VARYING DURATION AND FREQUENCY. Timush, D. M. (Inst. of Atomic Physics, Bucharest). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 811-16(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 156-61(May-Jun 1970).

A comparative analysis of series and parallel circuits for connecting thyratrons in pulse generators for accelerators shows that the parallel circuit has definite advantages. There is a brief description of a generator built on the basis of such a circuit and giving pulses with an amplitude up to 10 kV, a repetition frequency of 5 to 400 cps, and a duration of 5 to 300 μsec. (auth)

21471 LINEAR SWITCHING DEVICE WITH WIDE DYNAMIC RANGE. Bibichev, B. A.; Sheremet'ev, A. K. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 796-7(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 145-6(May-Jun 1970).

A simple switching circuit with linear characteristics, using two switching transistors and a control signal generator, is described. The circuit requires no adjustment, has a stable pedestal of no more than 4 mV, a dynamic range no less than 1000, and a switching time of ~0.6 sec. (auth)

21472 REDUCTION OF DIFFERENTIAL NONLINEARITY IN AMPLITUDE CONVERTERS. Glushkovskii, M. E. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 793-5(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 142-4(May-Jun 1970).

A method of reducing differential nonlinearity in amplitude converters using an amplitude-time-code type conversion is described. The block diagram of an actual device using this method which was

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tested with a BAP-6 converter is given. Diagrams showing the improvement in converter characteristics attained with this device are shown. (auth)

21473 WIDE RANGE TIME-AMPLITUDE CONVERTER. Sanin, A. A.; Shareiko, P. N. (Inst. of Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 788-92(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 136-41(May-Jun 1970).

A circuit for a wide-range time-amplitude converter using a triggered multivibrator is presented. The converter's usable range of 1 to 100 nsec can be increased to tens of μsec. For a 100-nsec range the inherent resolving time of the converter is 0.1 nsec. Nonlinearity is no more than 1%. Temperature instability for a 30-nsec measurement range is approximately 10 nsec/°C (20 to 50°C). (auth)

21474 CORRECTION OF SPECTRA OBTAINED FROM MULTICHANNEL ANALYZERS FOR DRIFT IN NULL POINT AND AMPLIFICATION. Egiazarov, B. G.; Selyutin, R. P. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 784-7(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 134-6(May-Jun 1970).

Correction of spectra obtained in multichannel analyzers is usually done by rectilinear interpolation. It is shown that such an interpolation distorts the areas below the photopeaks all the more, the greater the variation in amplification of the spectrometer channel. A modification is proposed which permits correction for changes in amplification up to 5 to 7% with accumulations of up to ~10^6 impulses in the analyzer channel. (auth)

21475 NEUTRON INTERRUPTER (CHOPPER) AND MONOCHROMATOR WITH SYNCHRONOUSLY-ROTATING ROTORS SUSPENDED IN A MAGNETIC FIELD. Kalebin, S. M.; Rukolaine, G. V.; Adib, M. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 721-5(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 79-83(May-Jun 1970).

The constructions of a neutron interrupter and monochromator with synchronously-rotating rotors suspended in a magnetic field are described. The interrupter has two rotors 50 and 30 cm in diameter. The neutron monochromator has five rotors. Two of these are 50 and three 30 cm in diameter. The rate angular velocity of the rotors extends up to 18,000 rpm. The phase of the rotor rotation is constant to an accuracy of ±0.04°. A background curve characterizing the operation of a neutron interrupter with synchronously-rotating rotors placed directly in the beam of a reactor is presented. (auth)

21476 SAFETY SHUTTER FOR USE ON X-RAY GENERATORS. Farnum, E. H. (Sandia Labs., Albuquerque, N. Mex.). Rev. Sci. Instrum; 42: 309-11(Mar 1971).

A simple shutter has been constructed to increase the safety of x-ray generators used in routine diffraction work. It has been designed to permit easy alignment of an x-ray camera while minimizing the possibility of accidental release of the x-ray beam. Failsafe and nearly foolproof, the shutter is particularly suitable where many operators may be using the same x-ray generator. (auth)

21477 CRYOSTAT FOR LOW ENERGY ELECTRON DIFFRACTION WORK AT LIQUID HELIUM TEMPERATURES. Strongin, Myron; Dickey, J. M.; Farrel, H. H.; Arns, T. F.; Hrabak, G. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum; 42: 311-15(Mar 1971).

An apparatus is discussed which has been successfully used for low energy electron diffraction (LEED) experiments at liquid helium temperatures. Problems such as sample cleaning and thermometry are discussed, along with a description of the use of the apparatus in an experiment where argon crystals were grown on the niobium (100) face. (auth)

21478 METASTABLE ATOM PROBE FOR MEASUREMENT OF ELECTRON BEAM DENSITY PROFILES. Lockhart, James M.; Zorn, Jens C. (Univ. of Michigan, Ann Arbor). Rev. Sci. Instrum; 42: 315-18(Mar 1971).

A well collimated thermal beam of argon atoms, moving in the z direction, crosses the electron beam that is to be studied. Those argon atoms that are excited by impact to a metastable state proceed, with very little change in speed or direction, to a detector (windowless electron multiplier) some distance away. The neutral atomic beam of the metastable atom probe (MAP) has a negligible interaction with the electromagnetic fields that govern the behavior of the electron beam; moreover, almost no additional space charge is created when the atomic beam is introduced. Thus, if the cross section of the atomic argon beam is small compared to the characteristic dimensions of the electrode structure that defines the electron beam, the metastable atom count rate, monitored as a function of x and y, gives a virtually nonperturbative measurement of the density profile of the electron beam. The principles and applications of the method are outlined, details of its implementation are discussed, and results obtained with an MAP that has a spatial resolution of better than 0.5 mm are given. (auth)

21479 NOVEL METHOD OF PULSING OF EXCITING RADIATION FOR DECAY MEASUREMENTS. Abbruscato, V. (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Rev. Sci. Instrum; 42: 390-1(Mar 1971).

A chopper-type beam pulser for a radiation source to be used for decay measurements of radioinduced luminescence in phosphors is described. The pulser employs two sets of vanes in parallel motion out of phase. (W.H.K.)

21480 ELECTRON BEAM AND FLASH X-RAY DIAGNOSTICS. Walker, Jack V. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 284-94(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A review of some diagnostic techniques and instrumentation used at Sandia Laboratories for studying intense electron beams and laboratory pulsed x-ray sources is presented. Included are descriptions of current monitors, radiation sensitive polymer films, and calorimeter arrays for beam energy density measurements. Also discussed is the real time-on line digital computer used for calorimetry measurements. A new technique for measuring electron energy as a function of time is presented and representative data from Sandia's Hermes-II facility are shown. These data are in turn used with a Monte Carlo code to determine the bremsstrahlung spectrum, which is compared with a direct photon measurement made with a large Compton spectrometer. Finally, a discussion is given of the use of these data in radiation effects experimentation. The results of combined photon-electron transport calculations are shown which demonstrate the edge and interface effects which are important for thin and inhomogeneous samples. (auth)

21481 DEVICE FOR STUDYING RADIATION EFFECTS IN SHETLAND PONIES. Morgan, A. H.; Brown, D. G.; Thomas, T. H. (Univ. of Tennessee, Oak Ridge). Tenn. Farm Home Sci., Progr. Rep.; No. 74, 2-5(Apr-Jun 1970).

A hydraulic dynamometer which was designed to evaluate the physical fitness of Shetland ponies after recovery from the early effects of irradiation is described. (W.H.K.)

21482 MASS SPECTROMETER FOR THE SIMULTANEOUS MEASUREMENT OF THE NEUTRAL AND THE ION COMPOSITION OF THE UPPER ATMOSPHERE. Balsiger, H.; Eberhardt, P.; Geiss, J.; Kopp, E. (Univ., Bern). Rev. Sci. Instrum.; 42: 475-6(Apr 1971).

A mass spectrometer is described which measures the neutral and the ionized components of the upper atmosphere simultaneously (delay ~20 msec). Its 1% mass resolution is 60 and its sensitivity is sufficient to measure small ion concentrations in the presence of high neutral gas densities. During rocket flights the shift in the mass scale between the ion peak and the corresponding neutral peak is a measure for the rocket spin potential. (auth)

21483 OPTICAL MAGNETOMETER FOR SUPERCONDUCTIVITY MEASUREMENTS. Griffiths, David J. (Oregon State Univ., Corvallis). Rev. Sci. Instrum.; 42: 444-7(Apr 1971).

The magneto-optical Faraday effect associated with certain paramagnetic ions has been utilized to construct an optical magnetometer suitable for studying the magnetic properties of hollow cylinder superconductors. As an instantaneous field detector, the response of the system in general is limited only by the spin–bath relaxation time of the paramagnetic ion-host crystal system being used. The magnetometer has the advantage of requiring no moving parts and also avoids the necessity of having to extract a low level voltage signal from the low temperature environment. Also, since the detector is an insulator, there are no undesirable time derivative of field signals generated in its used. The operating field range is limited by the sensitivity desired in a given experiment. For fields up to 13.5 kOe at a temperature of 2.15 K, the sensitivity for the analyzer oriented at 45° with respect to the plane of polarization of the emergent light is at worst ±9.3 Oe. The text lists the sensitivity at various other fields and temperatures in tabular form. Initial results on superconducting hollow cylinder niobium are also presented. (auth)

21484 DEVELOPMENT OF A COMPTON POLARIMETER WITH SOLID STATE DETECTORS. Hardy, K. A. (Johns Hopkins Univ., Baltimore); Lumpkin, A.; Lee, Y. K.; Owen, G. E.; Shnidman, R. Rev. Sci. Instrum.; 42: 482-4(Apr 1971).

A two-section Compton polarimeter has been developed out of a single Ge–Li detector. This device has nearly the same asymmetry ratio as the three-section polarimeter described previously, but has the advantage of a high efficiency. The asymmetry ratio of the device is calculated as a function of gamma ray energy. The polarimeter is also calibrated by gamma rays of known polarization from reactions $^{24}Mg(p,p')$ and $^{28}Si(p,p')$. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 22213, 22578, 22586, 22609, 22610, and 22615.

21485 (N-70-43156) RADIATION EFFECTS IN SILICON SOLAR CELLS. Quarterly Progress Report, July 1–September 30, 1970. Berger, R. A.; Colwell, J. F.; Leadon, R. E.; Naber, J. A.; Passenheim, B. C. (Gulf Radiation Technology, San Diego, Calif.). 10 Oct 1970. Contracts NAS7-100; JPL-952387. 29p. (NASA-CR-110891; GA-10344). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

The nature of the defects responsible for the degradation in output of silicon devices (solar cells) irradiated by space radiation was studied for the following reasons: (1) to determine the parameters that will lead to development of radiation-hardened devices, (2) to predict the effects of radiation and annealing on solar cells, and (3) to make use of computer programs to predict radiation effects in solar cells on extended space flights. The effects of lithium on the production and annealing of damage in silicon are presented. This work is being performed on lithium-diffused bulk silicon using measurements such as minority-carrier lifetime, electron-spin resonance, electrical conductivity, and infrared absorption. The temperature range from 77.5 to 400 K is under investigation. The damage is introduced by 30-MeV electrons and fission neutrons. (auth) (STAR)

21486 ANNUAL CONFERENCE ON NUCLEAR AND SPACE RADIATION EFFECTS, LA JOLLA, CALIFORNIA, JULY 21–23, 1970. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 1-389(Dec 1970). (CONF-700713).

Separate abstracts were prepared for the 60 papers presented. (W.H.K.)

For abstracts of individual papers see: 21448, 21480, 21487–21527, 22355, 22574–22577, 22609–22619, and 23004.

21487 RADIATION-INSENSITIVE SILICON OXYNITRIDE FILMS FOR USE IN SILICON DEVICES. PART II. Schmidt, P. F.; Ashner, J. D. (Bell Telephone Labs., Inc., Allentown, Pa.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 11-17(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Studies on the interface state densities at the Si/Silicon Oxynitride (SiON) interface before and after ionizing irradiation, on extended bias–temperature tests on Si/SiOn capacitors, and on the fabrication and properties of SiOn passivated bipolar transistors and P-channel IGFETs are reported. Preliminary data are also presented for gold and copper diffused capacitor structures. (auth)

21488 ELECTRIC FIELD STRENGTH DEPENDENCE OF SURFACE DAMAGE IN OXIDE PASSIVATED SILICON PLANAR TRANSISTORS. Goben, C. A.; Irani, C. H. (Univ. of Missouri, Rolla). Contract AT(11-1)-1624. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 18-26(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A dependence of surface degradation induced by ionizing radiation in matched oxide-passivated silicon planar epitaxial transistors on junction fringing electric field strength present during exposure is reported. The electric field strength and gamma dose dependence are investigated for the decrease in the forward current gain, h_{FE} (as reflected by the increase in the surface recombination current component), the increase in the surface recombination velocity (as reflected by the increase in the reciprocal of the minority carrier lifetime), and the increase in junction capacitance. Empirical prediction equations have been derived, for matched devices, correlating the normalized base current increase and the normalized surface recombination velocity increase with the average junction electric field strength present during irradiation and the total gamma dose. The ionizing radiation induced surface recombination and surface channel components are analyzed from a study of the reciprocal slope term, "n", obtained from forward and inverse configuration current-voltage data. (auth)

21489 PERMANENT RADIATION EFFECTS IN HARDENED Al_2O_3 MOS INTEGRATED CIRCUITS. Micheletti, F. B.; Zaininger, K. H. (RCA Labs., Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 27-32(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Complementary-symmetry metal-oxide semiconductor (COS/MOS) inverter circuits have been fabricated with aluminum oxide as channel insulator. This oxide was formed either by plasma-anodization of Al or by vapor deposition at 450°C using Al-isopropoxide. The RCA CD-4007 circuit configuration was used for these studies. The inverters were subjected to ionizing radiation with the applied gate biases encountered under normal operation (0 and +10 volts). For all units tested, the shifts in the inverter characteristics were due to shifts in the threshold voltages of the individual transistors. No measurable deterioration in gain due to interface state generation was observed. These results confirm the expected radiation hardness measured previously with MOS capacitors. Based on the net voltage shifts in the transfer characteristics of the complementary inverters, plasma-grown Al_2O_3 shows an increase of more than an order of magnitude in hardness over units with SiO_2 channel oxide. The hardness of units with deposited Al_2O_3 was found to be intermediate to these. The increased hardness of Al_2O_3 over SiO_2 is attributed, at least in part, to the presence of trapping centers for negative charge. This serves to balance the positive trapped oxide charge so that a considerable reduction in the net oxide charge is attained. (auth)

21490 LONG-TERM EFFECTS OF RADIATION ON COMPLEMENTARY MOS LOGIC NETWORKS. Poch, W. J., Holmes-Siedle, A. G. (RCA Astro-Electronics Div., Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 33-40(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

When exposed continuously to a radiation source, p-channel transistors normally need increasing values of negative gate voltage to maintain constant drain current. N-channel transistors, on the other hand, need decreasing values of positive gate voltage to maintain constant drain current. A recently published report described these effects in detail and, in particular, showed that the mode of biasing and cycling of the devices can have a profound effect on the ability of an MOS device to survive a given environment. This study has now been extended to include Complementary-Symmetry MOS (CMOS) networks which incorporate a number of p- and n-channel transistors on a single silicon chip, frequently in the form of series-connected inverter pairs. These devices have rapidly gained acceptance for use in logic circuitry because of their inherently high noise-immunity and low power drain. The radiation-induced failure modes of CMOS pairs have been analyzed and determined for a variety of operating conditions. These results form the basis for predicting the dose levels that will induce failure in more complex CMOS devices which are available. (auth)

21491 USE OF PHOTOINJECTION TO DETERMINE OXIDE CHARGE DISTRIBUTIONS AND INTERFACE PROPERTIES IN MOS STRUCTURES. Powell, R. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 41-6(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Determination of the distribution of oxide charge and interface properties is important to an understanding of oxide charging phenomena such as that produced by irradiation. The physical mechanism dominating the voltage dependence of photoinjected currents in SiO_2 is the scattering of electrons in the region of the oxide between the injecting electrode and the image force potential maximum. Since the spatial position of the potential maximum depends on the electric field resulting from space charge in the oxide as well as the field due to the applied voltage, analysis of the V-I characteristics of photoinjected currents can provide information about the spatial location of oxide charge. The results of an analysis of the effects of oxide space charge on the voltage dependence of photoinjected currents are presented. It is shown that charge distribution in SiO_2 can be non-destruc-

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tively profiled over a range from about ten to several hundred angstroms from the injecting electrode. Since photoinjection V-I characteristics depend on electric field at the potential maximum in the oxide, whereas C-V characteristics depend on the field just inside the semiconductor, analysis of both characteristics permits distinction between charge in the oxide a distance greater than about 10 Å and charge located at the interface. The results of experiments on Au-SiO_2-Si structures in which charge has been purposely introduced into the oxide is presented and it is shown that the interface fixed charge and the charge associated with fast surface states are located within about 20 Å of the Si–SiO_2 interface. (auth)

21492 RADIATION INDUCED CURRENTS ACROSS Al_2O_3 FILMS. Lee, R. S. (Kansas State Univ., Manhattan.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 47-51(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Films of Al_2O_3 sandwiched between thin metal electrodes have been irradiated using continuous radiation from a cobalt target x-ray tube operated at 35 kV. Current through the Al_2O_3 films was measured as a function of voltage and time during x-irradiation. Implications of these measurements regarding radiation induced charge trapping in oxide films are discussed. (auth)

21493 INVESTIGATION OF THE SURFACE IONIZATION ON PLANAR SILICON BIPOLAR TRANSISTORS AND THE IMPROVEMENT OF THE RESISTANCE TO RADIATION BY AN IRRADIATION-ANNEALING TREATMENT. Baeuerlein, R. (Siemens AG, Erlangen, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 52-62(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

By irradiation of the surface structure of silicon planar transistors with a narrow electron beam adjusted parallel to the pn-junctions of the devices it was possible to show in a very direct manner that the increase in base current occurs only if the beam is directed to the immediate vicinity of the emitter-base pn-junction. Subjecting the collector-base pn-junction and the remainder of the transistor surface to radiation has no effect on the current gain. A comparison of the radiation damage to bipolar silicon planar transistors in metal packages and plastic envelopes shows that the packaging method has a strong influence on the degradation in current gain if the pn-junctions are reverse-biased during the irradiation. The resistance of bipolar planar transistors to ionizing radiation can be improved considerably if the device is subjected to a high dose of ionizing radiation under conditions at which the damage anneals out immediately. The cause for this phenomenon mainly is a decrease of the concentration of interface states effected by this treatment. Reductions of the increase in base/collector current ratio of one order of magnitude have been obtained. (auth)

21494 MODELING OF THE SATURATION CHARACTERISTICS OF HIGH VOLTAGE TRANSISTORS. Gwyn, C. W.; Summers, G. G.; Corbett, W. T. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 63-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The conventional Ebers-Moll model does not provide an accurate representation of the saturation region characteristics for transistors with a high resistivity collector region. Accurate one-dimensional calculations of device characteristics indicate that the size of the effective collector resistance is modulated at high currents by the extension of the neutral base into the collector region. Based on this analysis, a non-linear collector resistance is added to the Ebers-Moll equivalent circuit model to provide a more accurate representation of the characteristics in the saturation region. (auth)

21495 SIMPLE AND EFFICIENT SWITCHED-MODE APPROACH TO HARDENED POWER AMPLIFICATION. Palkuti, L. J.; Kalinowski, J. J. (Battelle Memorial Inst., Columbus, Ohio). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 70-5(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A radiation-hardened power amplifier using switched-mode techniques to effect linear amplification is described. The amplifier — consisting of a modulator, saturating switches, and a demodulator — is capable of delivering more than 50 watts peak output at an efficiency exceeding 60 percent, before and after exposure to 3.5×10^{14} n/cm^2 (1-MeV equiv.) and 2.0×10^6 rads (Si). The amplifier is immune to catastrophic effects of a pulsed ionizing-radiation environment of short duration through peak dose rates exceeding 1×10^{11} rads (Si)/s. The magnitude of the output response at this level is less than 9 percent of the maximum output voltage, and recovery from transient ionization takes place within one cycle of the amplifier's 3-db cutoff frequency. (auth)

21496 RADIATION HARDENED REGISTERS. Hampel, D.; Prost, K. J. (RCA Corp., Somerville, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 76-82(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The requirement for radiation hardened registers has been identified for use with existing digital equipment to assure system survivability in nuclear radiation environments. The major problem has been that all semiconductor registers cannot be guaranteed to maintain their information after ionizing radiation transients above 5×10^9 rads (Si)/sec. Two approaches are shown for designing microelectronic register circuits for increased transient immunity based on the use of temporary storage media: a magnetic circuit and a capacitor circuit. The operation of the circuits are described as well as the features which impart hardness to them. They are compatible with +5V, IC families of saturated logic and are proposed for use with these circuits for specific function hardening. The results of transient tests show the magnetic circuit to work through 10^7 rads (Si)/sec to 8×10^{10} rads (Si)/sec. The capacitor circuit tests went up as high as 5×10^{10} rads (Si)/sec. Laboratory simulation on the capacitor circuit (using shunting transistors to approximate the effect of the circuit's transistors storage times caused by radiation) indicates hardness to levels in excess of 5×10^{11} rads (Si)/sec. (auth)

21497 APPROACHES TO SYSTEM HARDENING. Poll, R. A. (Systems, Science, and Software, La Jolla, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 83-90(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The nuclear explosion environment and its effects upon systems are outlined; and various approaches to electronic system hardening are discussed. (W.H.K.)

21498 COMPONENT VULNERABILITY ANALYSIS OF MICROCIRCUITS. Raymond, James P. (Northrop Corporate Labs., Hawthorne, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 91-5(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The use of the detailed microcircuit model as the basis for derivation of terminal device characteristics applicable, in turn, to analysis of interconnected microcircuit networks is illustrated. Results are presented on the component analysis of three types of digital single-function gates: the junction-isolated MC507 and MC3026 TTL gates and the dielectric-isolated DTμL 969 gate. D-C electrical performance is considered as affected by neutron-induced lifetime degradation and steady-state ionizing radiation-induced carrier generation. Transient ionizing radiation effects and electrical switching is represented by defining a simple topological form and parameter values for the terminal model. (W.H.K.)

21499 EFFECTS OF IONIZING RADIATION ON MONOLITHIC PMOS INVERTERS. Cooper, J. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 96-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The problem of radiation hardening of metal-oxide-semiconductor (MOS) systems is discussed from a circuit viewpoint. An inverter chain is studied, and its performance in radiation is related to device quality. Techniques for testing and hardening circuits are given. (auth)

21500 SHORT-TERM ANNEALING IN p-TYPE SILICON. Harrity, J. W.; Mallon, C. E. (Gulf Radiation Tech., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 100-4(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A series of experiments was performed to study the effects of acceptor-type, carrier-concentration, and material-growth techniques on the short-term annealing of neutron damage to p-type silicon. No significant dependence of the annealing on these parameters was observed. The parameter most important

to the annealing rate is the injected minority-carrier concentration (Δn). The use of extremely low injection concentrations, a very short neutron burst, and early time measurements has resulted in the detection of anneal factors as high as 50 in the tests reported. No anneal factors of this magnitude have ever been reported before. (auth)

21501 NEUTRON HARDNESS ASSURANCE FOR POWER TRANSISTORS. Niehaus, D. (Bendix Research Labs., Southfield, Mich.); Stoll, E.; Swick, E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 154-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A method for providing neutron hardness assurance for power transistors based on correlation techniques and the application of a group of screening parameters has been successfully demonstrated. Prediction of power transistor gain and saturation voltage at high currents in neutron environments is complicated because of the combined effects of carrier lifetime degradation and carrier removal in base and collector regions of transistors. Simple base region recombination models are not adequate and a two-region, two-dimensional analytical model describing transistor radiation response at high currents is not yet available. However, statistical techniques can be applied to experimental data obtained on sample devices from a production line to derive equations that correlate device radiation performance with selective nondestructive electrical screening measurements. Hardness assurance of each subsequent part from specific production line is accomplished by applying individual device screening data to the derived equations and evaluating predicted response in accordance with desired performance criteria. (auth)

21502 STATISTICAL ANALYSIS OF NEUTRON-INDUCED GAIN DEGRADATION OF POWER TRANSISTORS. Rosenberg, C.; Arimura, I.; Unwin, A. M. (Boeing Co., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 160-6(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Predictions of low neutron fluence failure probabilities of silicon power transistors are of particular interest since this device type is among the most vulnerable in systems operating in nuclear environments. The Weibull distribution can be used for this, but so far attempts to do so have not been too successful. This work attempts to use more statistically significant sample sizes and a more ideal neutron environment to study four representative device types, two NPN and two PNP. An important result is the extreme sensitivity of the shape of the Weibull plot to the definition of failure. Three definitions are used: (1) minimum remaining fractional gain, (2) minimum remaining absolute gain, and (3) minimum transit-time-normalized damage constant. The effects of these and of various screens on the resulting Weibull plots are noted and discussed. With few exceptions, the observed failure distributions do not fit a simple Weibull distribution suitable for extrapolation to low failure rates. Screening effects can vary over a broad range from truncation of a Weibull function to linearizing a nonlinear distribution to the point that extrapolation is made possible. The efficacy of any combination of failure criterion and screen to describe neutron-induced gain distribution is limited in applicability to certain ranges of device type and current. (auth)

21503 TOTAL-DOSE SURVIVAL PROBABILITY FOR BIPOLAR TRANSISTORS. Horne, W. E.; Folsom, J. A. (Boeing Co., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 167-72(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Four samples of one hundred devices each were tested. Three transistor types, consisting of 200 of type 2N1613, 100 of type 2N2219, and 100 of type 2N3420, were irradiated under various bias conditions in a Co-60 gamma environment at a rate of 7.6×10^3 Rads (Si)/hour and an ambient temperature of 25°C. Data are presented in terms of percent failure versus dose [up to 5.8×10^5 Rads (Si)] for a family of failure criteria and for a family of measurement conditions. It is concluded that (1) the Weibull distribution seems to be adequate as a means of predicting low-dose survival probability if care is taken to fully characterize the one or more distributions present. For the devices studied, there is not a minimum value for damage threshold; however, in two device types there does appear to be either more than one failure mode present or else two distributions. (2) the Weibull technique can be used to indicate manufacturing variations in device lots and, when combined with parameter frequency charts, may provide a screening technique or a monitor on the quality of semiconductor device surfaces. (3) Ionizing radiation may in many cases be the dominant environmental component to consider when projecting component and system reliability since 0.1 percent failure probabilities can occur at doses of the order of 10^3 rads. (4) operating conditions during irradiation have a significant effect on the reliability of at least the 2N1613 device type. The radiation reliability was decreased when 20 V collector voltage and 0.10 ma were applied during radiation as opposed to a non-operating device. (auth)

21504 METHOD FOR AN ACCURATE PREDICTION OF DEGRADATION CHARACTERISTICS AND QUALITY ASSURANCE OF A 709 AMPLIFIER. Witteles, A. A.; Eisenberg, M. L. (Singer-General Precision Inc., Little Falls, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 173-82(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A novel method is presented whereby the neutron-induced degradation characteristics of semiconductor components can be predicted, and total assurance of operation can be attained even under severe radiation environments. The method, involving irradiation-annealing cycles is shown to be economical and reliable in the wafer stage, and feasible for packaged off-the-shelf hardened components. Radiation damage effects on semiconductors are discussed. Defect annealing phenomena is considered under a variety of temperature ambients. Experimental irradiate-anneal data is presented for both discrete transistors and IC dielectrically isolated 709 amplifiers manufactured by three different vendors. The results of a number of tests shows the feasibility of obtaining very accurate prediction of the components' degradation characteristics and as a result suggests the application of this method by the semiconductor vendor in supplying components with known quality assurance and "guaranteed" performance under a given neutron fluence. (auth)

21505 TECHNIQUE FOR OBTAINING RADIATION HARDENED SEMICONDUCTOR DEVICES BY IRRADIATING WAFERS. Cates, Harold T. (Martin Marietta Corp., Orlando, Fla.); Darling, Ray E.; Davidsohn, Ury. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 183-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A technique is described whereby irradiation of semiconductor wafers can be used as a 100 percent screening technique for assuring the radiation hardness of discrete semiconductors and integrated circuits on a production lot-to-lot basis. Experimental test results have proven the feasibility of using an irradiation and screening technique to assure semiconductor device performance in a neutron environment. The irradiation and annealing technique is economical, feasible, and effective when implemented at the silicon wafer stage. Power stress-to-failure studies of both irradiated and non-irradiated transistor dice in the final package show similar failure modes with no indication of reliability degradation due to repeated irradiations.

21506 SPACE RADIATION EFFECTS IN SCINTILLATING MATERIAL. Ebeoglu, D. B. (Bendix Aerospace Systems Div., Ann Arbor, Mich.); Doody, P. J. Jr.; Lowman, C.; Bender, M.; Long, J. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 205-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A series of tests was conducted in a space environment chamber to determine experimentally the space radiation effects in ZnCdS, $CaWO_4$, and CsI. The scintillating materials were exposed to electron and proton beams of varying energy and flux to determine techniques for reducing space radiation-induced light emission to a minimum. The objective was to determine whether scintillating materials could be used in a spacecraft to monitor signals from active sources. Electrons were found to contribute to the background light output via secondary x rays produced in the shielding materials, while protons were found not to have any effect on shielded scintillators. A lead aluminum sandwich geometry was shown to be the most effective means of shielding scintillating materials. (auth)

21507 RADIATION-INDUCED CURRENTS IN COAXIAL CABLES. van Lint, V. A. J. (Gulf Radiation Tech., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 210-16(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The effects of gamma and neutron radiation on coaxial cables should be described as a current due to kinetically moved charge

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and a conductivity. Simple models, using known cross sections for gamma and neutron interactions can be used to calculate the amount of charge displacement. The radiation-induced conductance of a cable can also be estimated from data on the dielectric material. Experimental data frequently show larger initial response than the estimates. The observed current is proportional to instantaneous dose rate or flux, but the proportionality factor is a generally decreasing function of dose or fluence, even changing signs in some cases. The anomalies suggest relaxation of space charges created in the dielectric by the manufacturing process or by physical motion. (auth)

21508 QUARTZ CRYSTAL RADIATION EFFECTS. Capone, B. R.; Kahan, A.; Brown, R. N.; Buchmelter, J. R. (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 217-21(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The effects of electron irradiation on frequency and on internal friction, Q^{-1}, of 5 MHz, 5th overtone, high precision AT-cut quartz resonators are evaluated. The oscillators were irradiated with 10 MeV electrons to a dose of 1 Mrad(Si), transient and permanent frequency shifts monitored, and resonator internal friction measured before and after irradiation in the temperature range of 4.2 to 475°K. This investigation was carried out under nearly identical manufacturing and experimental conditions on resonators fabricated from natural, electronic grade synthetic, lithium carbonate doped, lithium nitrite doped, low impurity content high-Q, and electrolyzed (swept) electronic grade synthetic quartz crystals. The swept synthetic crystal oscillator shows the highest radiation tolerance. (auth)

21509 NUCLEAR RADIATION DAMAGE TO RUBY LASERS. Halpin, J. J.; Wenzel, R. F. (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 222-6(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The power output of ruby lasers is decreased when they are exposed to high energy ionizing radiation. The causes for this degradation are: (1) the absorption of the laser light by a radiation-induced absorption at the lasing wavelength, (2) a change in the valence state of the lasing impurity, Cr^{3+} ions and (3) the absorption of the flash lamp pump light by radiation induced absorption. By experimentally determining the magnitude of each of these damage parameters, one is able to estimate for a particular absorbed dose the expected laser degradation. The technique for performing this calculation as well as the experimental verification of the prediction are reported. (auth)

21510 DESIGN OF NEUTRON RADIATION TOLERANT HIGH EFFICIENCY MICROWAVE AVALANCHE DIODE SOURCES (TRAPATT OSCILLATORS). EerNisse, E. P.; Chaffin, R. J. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 227-9(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The effects of permanent neutron damage on the operation of high efficiency avalanche microwave sources are explained. The resulting design criteria for increasing the neutron radiation tolerance of these devices are verified by comparing experimental results for two different device doping profiles. In terms of RF failure, the device with the narrower space-charge region is more radiation resistant. This is because RF failure is related to recombination of carriers as they transit the space-charge region. A theoretical curve predicting neutron damage failure versus frequency of operation is presented and shown to agree with the experimental data taken from the two different TRAPATT oscillators. The DC failure of the devices takes the form of a negative temperature coefficient at large reverse breakdown currents which is related to carrier removal at the edges of the space-charge region. In terms of this DC failure mechanism the device with the more abrupt doping profile is more radiation tolerant. (auth)

21511 RADIATION DAMAGE IN GaAs GUNN DIODES. Marcus, G. H.; Bruemmer, H. P. (Army Electronic Command, Fort Monmouth, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 230-2(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Both pulsed and CW GaAs Gunn oscillator diodes with initial carrier concentrations between 3.3×10^{14} cm^{-3} and 1.5×10^{15} cm^{-3} were irradiated in a series of steps to total accumulated neutron fluences as high as 1.12×10^{14} n · cm^{-2} ($E \geq 10$ keV). A low field I–V point was determined, and the frequency and output power were measured at the operating voltage for each device. Carrier removal rates were determined from the low-field resistance. Values ranged between 3.57 cm^{-1} for these devices and were found to vary as the 0.4 power of the initial carrier concentration. Output power ultimately decreased with increasing fluence, with device failure occurring between 2.4×10^{13} n · cm^{-2} and about 1×10^{14} n · cm^{-2}, increasing fairly linearly with the initial carrier concentration. The carrier concentration at device failure also depends linearly on the initial concentration. (auth)

21512 NEUTRON DISPLACEMENT EFFECTS IN EPITAXIAL GUNN DIODES. Berg, N.; Dropkin, H. (Harry Diamond Labs., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 233-8(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

To correlate the performance of Gunn diodes in a radiation environment with the radiation-induced defects in the active epitaxial layer of the device, radiation effects on Gunn diodes and Hall bars grown simultaneously were investigated. The results indicate that neutron-induced degradation in device efficiency is due to carrier removal, reduction of the peak- to valley-current ratio by low-field mobility degradation, and slow trapping of high-field conduction electrons. (auth)

21513 COMPARISON OF LIGHT EMITTING DIODES IN SPACE RADIATION ENVIRONMENT. Stanley, Alan G. (Massachusetts Inst. of Tech., Lexington). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 239-44(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The effect of electron irradiation on different types of commercially available light emitting diodes has been investigated. The following phenomena were studied as a function of electron fluences up to 10^{15} e/cm^2: changes in light intensity vs. voltage and current voltage characteristics, lens darkening and surface effects. The following materials were investigated in order of increasing radiation resistance: epitaxial GaAs, diffused GaAs, GaP, $GaAs_{1-x}P_x$ and SiC. Two types of pulsed GaAs laser diodes and a continuously operated YAG:Nd laser rod were also irradiated. The two most sensitive devices, epitaxial GaAs light emitting diodes and YAG:Nd lasers, showed significant losses in light output at fluences below 10^{12} e/cm^2. (auth)

21514 LOW ENERGY PROTON IRRADIATION OF SILICON SURFACE BARRIER DETECTORS. Aukerman, L. W. (Aerospace Corp., El Segundo, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 245-9(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Capacitance-voltage curves and low temperature capacitance-recovery techniques are used to determine the defect generation rate and energy levels in the depletion region of surface barrier radiation detectors (Schottky diodes) irradiated with low energy (.2 to .4 MeV) protons. The damage rate is about 1.3×10^{-2} net donor defects per proton, independent of energy. Most of the damage is created close to the end of the proton range. After room temperature stabilization energy levels were found at $E_c - 0.24$, $E_v + .26$, $E_v + .32$, and $E_c - .47$. The capture cross sections suggest that the second and fourth levels are donors and the third an acceptor. The fourth is the major level. Most of the damage anneals in the 100°C to 200°C range. These properties do not correlate well with the properties of the divacancy, a defect prominent in neutron irradiated silicon. The annealing behavior, on the other hand, suggest that the major defect is the Si P-3 defect. (auth)

21515 LOW-ENERGY PROTON DAMAGE TO SILICON SOLAR CELLS. Stofel, E.; Joslin, D. (Aerospace Corp., El Segundo, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 250-5(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The effect of low-energy (<2 MeV) proton irradiation upon the junction properties of silicon solar cells has been measured. These measurements are used to explain the large power loss observed on the ATS-1 and Intelsat II-4 satellites. (auth)

21516 NOISE FROM NEUTRON INDUCED DEFECTS IN JUNCTION FIELD EFFECT TRANSISTORS. Kern, H. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 256-61(Dec 1970).
From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Neutron damage centers in the depletion region between the

gates and channel of a JFET fluctuate in charge and modulate the drain current. Thus, they create noise. The noise from 10^{12} 14.8 MeV neutrons/cm^2 is easily measured. Temperature dependence of leakage current indicates a neutron damage generation-recombination level effective at about $E_c - 0.5$ eV. The noise spectral distribution cannot be adequately characterized by a two state trap with single characteristic lifetimes for the two states. (auth)

21517 EFFECTS OF FAST NEUTRON IRRADIATION ON THERMOCOUPLES. Hoitink, N. C.; Weddle, R. C.; Thompson, D. C. (Wadco Corp., Richland, Wash.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 262-7(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

As part of a program aimed at establishing performance characteristics of thermocouples to assure reliable sensors for measuring coolant temperature in the Fast Test Reactor (FTR) thermal and nuclear environment, 22 Chromel/Alumel thermocouples have been tested before and after exposure in the EBR-II nuclear reactor. Neutron exposure totaled 7×10^{21} nvt with an irradiation temperature of 1050°F. The 30-in. (76.2 cm) long, 0.0625-in. (0.159 cm) diameter, stainless-steel-sheathed, MgO-insulated thermocouples included both grounded- and insulated-junction types. As thermocouples for use in the FTR may experience exposures between 10^{21} and 10^{22} nvt, the described program emphasizes the determination of the type and extent of damage. Effects on the sensors from fast neutron irradiation may include calibration shifts, wire resistance changes, response time changes, and variations in insulation resistance. (auth)

21518 CURRENT DEPENDENCE OF THE NEUTRON DAMAGE FACTOR. Ramsey, C. E.; Vail, P. J. (Air Force Weapons Lab., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 310-16(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The current dependence of the neutron damage factor for transistor beta degradation was correlated with the carrier transit time across both the emitter-base junction and the base region of a transistor. An electrical measurement related to this transit time was used to generate current-independent damage factors for 100 devices of 16 types. The use of the junction delay in addition to the base transit time was based on recent work which indicated the importance of this region in transistor beta degradation. From this work it appears that a graphical method can be used to separate the components of damage occurring in the base and in the emitter-base depletion region. Because the damage factor is independent of current, a single value can be determined for a given transistor type and used as a figure-of-merit for hardness assurance when divided by the gain-bandwidth product of the transistor at the operating current. This new damage "constant" should be more effective than the present damage factor in hardness assurance screens because its coefficient of variation is smaller at low currents. (auth)

21519 NEUTRON DEPENDENCE OF NEUTRAL BASE REGION RECOMBINATION. Bereisa, J. Jr.; Goben, C. A. (Univ. of Missouri, Rolla). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 317-24(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A discrete, deterministic mathematical model has been developed for the bulk base region of graded base devices that accounts for both the effects of neutron-induced recombination and built-in electric field in the base region at low, intermediate, and moderate current/injection levels. Exact expressions are developed for the bulk base recombination current and the collector current as functions of neutron fluence. Exact expressions are derived for the base recombination term and the relative rates of neutron-induced base current increase and collector current decrease. These expressions involve exponential and hyperbolic functions and are well suited for numerical computations and theoretical analysis. Damage coefficients for the bulk base recombination current and for the collector current are computed theoretically and are experimentally verified. (auth)

21520 APPLICATION OF NEUTRON DAMAGE MODELS TO SEMICONDUCTOR DEVICE STUDIES. Gregory, B. L.; Gwyn, C. W. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 325-34(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A hybrid recombination model has been formulated for neutron irradiated silicon which correctly predicts the minority carrier recombination in both the neutral and space charge regions of a device. Exact, one-dimensional, numerical calculations have been performed using this model and compared to reported V–I characteristics of irradiated p^+n diodes. The calculated curves agree with the reported data within 20% over the seven decade span of currents in the investigations for diode base resistivities from 0.25 Ω-cm to 17 Ω-cm. At low injection levels the calculated recombination occurs predominantly in the junction space charge region, whereas at high injection both the space charge region and neutral region can be important. Calculations have also been performed for the recombination occurring throughout a typical NPN silicon transistor. The results indicate that space charge region recombination is probably dominant in modern, narrow base transistors even at high injection levels. (auth)

21521 RADIATION EXPOSURE OF A LITHIUM NIOBATE CRYSTAL AT HIGH TEMPERATURES. Halverson, S. L.; Anderson, T. T.; Gavin, A. P.; Grate, T. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 335-40(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Lithium niobate is being considered for use as the active element in piezoelectric transducers in a nuclear reactor. For tests in a simulation of this environment, a Y-cut disk of this material 1 cm in diameter and 0.1 cm thick was mounted in a holder designed to allow measurement of piezoelectric properties of the materials, and was exposed to 4×10^9 R of ^{60}Co gamma rays at elevated temperatures in air. Exposure was at a dose rate of 1.75×10^7 R/h with approximately one half of the dose accumulated at 281°C and half at 537°C. The piezoelectric properties showed no changes that would affect the usefulness of the material for the intended purpose. (auth)

21522 SPACE-CHARGE REGION OF NEUTRON-IRRADIATED SILICON p^+n JUNCTIONS. Buehler, Martin G. (Texas Instruments Inc., Dallas). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 341-7(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A model has been developed describing the space-charge region of silicon p^+n junctions in the presence of deep traps. These traps are assumed to be defects with discrete energy levels in the forbidden energy gap. This model is applied to high frequency (1 MHz) capacitance-voltage measurements of two neutron-irradiated silicon p^+n junctions where $N_d = 5 \times 10^{14}$ cm^{-3} and 10^{15} cm^{-3}. It was found that two acceptor traps at $E_c - 0.4$ eV and $E_c - 0.58$ eV adequately fit the data. Since the divacancy has similar levels, the divacancy is a logical defect to assign to these levels. In addition, it was found that the defect introduction rate was 0.95 cm^{-1} for one of the junctions ($N_d = 5 \times 10^{14}$ cm^{-3}), fabricated in bulk material; whereas, for the other junction ($N_d = 5 \times 10^{14}$ cm^{-3}), fabricated in epitaxial material, the defect introduction rate was 0.64 cm^{-1}. These rates are consistent with those reported previously in the literature. (auth)

21523 EFFECTS OF CIRCUMVENTION AND TEMPERATURE ON NEUTRON-INDUCED RAPID ANNEALING. Arimura, I. (Boeing Co., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 348-53(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The rapid annealing behavior of silicon NPN transistors irradiated with fission neutrons at the Sandia Pulsed Reactor (SPR-II) was investigated. The annealing which normally occurs in the unobservable period during and shortly after the ~50 μs wide neutron burst has been shown to be considerably reduced by removing bias to the device during the burst (current "circumvention"). Room temperature annealing factors greater than three were observed for nearly all devices when bias was reapplied after the burst, even for high collector currents and after considerable circumvention times. These annealing factors were considerably larger than ones measured using comparable dc injection levels, indicating that a substantially greater portion of the recovery was observed using current circumvention. By following a greater portion of the recovery, very little difference was observed between annealing rates at 132°K and 300°K when annealing curves were normalized to unity total change. An activation energy of less than .02 eV was obtained by comparing the times for 50 percent annealing to occur at different temperatures. This value is significantly less than ~.3 eV activation energy obtained in previous studies. The circumvention technique also allowed a quantitative method for measuring the injection dependence of rapid annealing. The results for the 2N1613 indicated widely different annealing factors were

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joined into a single annealing curve when plotted as a function of injection charge (time-integrated current). (auth)

21524 RESPONSE OF BIPOLAR TRANSISTORS TO COMBINED EMP AND IONIZATION ENVIRONMENTS. Habing, Donald H. (Sandia Lab., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 360-3 (Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

In many circuit applications, semiconductor junctions will be highly ionized when EMP induced voltage and current surges are applied to device terminals. Results from a series of experiments which were performed to investigate the effect of high ionization rates (5×10^{11} rads (Si)/sec) on the pulsed current failure level of a bipolar transistor are presented. Exposure of the devices to simultaneous EMP and ionization environments showed that the forward biased base emitter junction damage threshold was significantly lowered. (auth)

21525 PULSE POWER FAILURE MODES IN SEMICONDUCTORS. Tasca, Dante M. (General Electric Co., Philadelphia). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 364-72(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Semiconductor devices operating under both biased and unbiased conditions are vulnerable to permanent damage from relatively moderate levels of pulsed electrical energy, particularly of submicrosecond pulse duration. An experimental study was performed to determine the permanent damage levels associated with a number of different devices and to identify the failure mechanisms associated with each. The device types investigated included general purpose and high speed computer diodes, a medium power diode, medium frequency and UHF transistor amplifiers, and a dielectrically isolated diode gate expander. The permanent damage levels associated with these devices were determined both for positive and negative polarity pulses at different conditions of quiescent bias and pulse width. The pulse duration times included the range of 30 to 300 nanoseconds, and in some instances, up to 1 microsecond. Failure models for both thermal second breakdown induced damage to the semiconductor junction and thermal damage to the device interconnecting leads and metallization patterns were also developed. (auth)

21526 THERMAL AND RADIATION STABILITY OF THIN-FILM CERMET RESISTIVE ELEMENTS. Tarpley, John L. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 373-9 (Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Recent laboratory experiments indicate that cermet thin-film resistors consisting of an 80/20 mixture of chromium and silicon monoxide can be fabricated to high sheet resistances up to 4500 ohms per square. These films show a pronounced thermal stability of <1 ppM/°C from −50°C to +175°C. Radiation stability of the films is ≤1% variance in absolute resistance for fluences up to 1×10^{15} e/cm^2 at a 1.5 MeV energy level. The cermet resistor may be controlled in fabrication to 1% accuracy for values well into the megohm range. The fabrication technique heavily influences the final value of sheet resistance as well as the ultimate thermal stability of the film. Annealing steps are very critical and play a major role in setting thermal stability characteristics. Annealing in a vacuum has been a very effective control and may be carried out without noticeable effects on active IC elements in the chip. The fabrication technique of cermet films is compatible with silicon technology. These thin-film layers introduce a minimum of parasitic capacitance into the IC circuit. Cermet thin-film resistors are worthy of consideration for deep space applications that demand such extreme resistor controls as; preciseness of values, wide range of values and thermal and radiation stability. (auth)

21527 NUCLEAR RADIATION ENHANCEMENT OF TRANSISTOR FORWARD GAIN AT HIGH FREQUENCIES. Goben, C. A.; Gray, D. L.; Han, Y. P. (Univ. of Missouri, Rolla). Contract AT(11-1)1624. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 380-8(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

This investigation characterizes the effects of fast neutron bombardment on a typical n−p−n transistor (2N914) of a common emitter amplifier operating at high-frequencies (>100 MHz) by means of s-parameter measurements from 120 MHz to 350 MHz, inclusive, every 10 MHz. The changes in the four (4) s-parameters and the trends and consequences of neutron bombardment are examined pictorially on graphs. The general effect of fast neutron bombardment is to decrease the magnitude of each s-parameter for frequencies below $z \cdot f_T$ [where $z = (\Phi/10^{13})^{0.1}$]. However, if the device is operating above $z \cdot f_T$, the magnitudes of s_{11} (input reflection coefficient) and s_{21} (forward insertion gain, which may be approximated by h_{fe}) increased above the pre-irradiation values, which would not be expected from previous work carried out at d−c and low frequencies. (auth)

21528 INFLUENCE OF GAMMA RADIATION ON SOME PARAMETERS OF P-INVERSION LAYERS IN THE Si/SiO_2 INTERFACE. Kassabov, J.; Velchev, N. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 1055-8(1970).

The effects of successive γ doses on the magneto-electrical parameters of Si p-inversion layers of MOS Halltron samples were studied. After the irradiation, changes in Hall voltage, Hall mobility, drift mobility, and threshold voltage were measured at two drain voltages of 1 and 12 V. The threshold voltage was found to increase, and the carrier mobility to decrease, with dose. (D.L.C.)

21529 ROLE OF ELECTRIC FIELD INHOMOGENEITIES IN SEMICONDUCTOR NUCLEAR RADIATION COUNTERS. Ryvkin, S. M.; Strokan, N. B.; Subashieva, V. P.; Tisnek, N. I.; Khusainov, A. Kh. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 4: 1107-12(Jan 1971).

Translated from Fiz. Tekh. Poluprov.; 4: 1303-10(Jul 1970).

An investigation was made of the influence of structure defects in n-type germanium on the energy resolution of counters prepared by the "cold" doping method. The samples were compensated by acceptor centers generated by irradiation with ^{60}Co γ quanta. The crystal blanks were scanned with a light probe and with a narrow beam of α particles. The topography of the signals generated by these probes reflected the degree of inhomogeneity of the original and irradiated germanium. Structure defects, which governed the breakdown voltage of p/n junctions, could be revealed by chemical etching of the surfaces of the disk-shaped blanks. An analysis of the nature of the amplitude spectra of the counters made it possible to estimate the dimensions and configurations of inhomogeneous regions and to separate the influence of inhomogeneous distributions of the electric field and carrier lifetime. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 21675 and 21676.

Basic Processes

Refer also to abstracts 21669, 21687, 21727, 21759, and 21781.

21530 PHYSICAL AND BIOLOGICAL PROPERTIES OF A ^{99m}Tc–SULFUR COLLOID PREPARATION CONTAINING DISODIUM EDETATE. Haney, Thomas A.; Ascanio, Ivan; Gigliotti, Joseph A.; Gusmano, Ernest A.; Bruno, Gerald A. (E. R. Squibb and Sons, New Brunswick, N. J.). J. Nucl. Med.; 12: 64-8(Feb 1971).

A procedure is described for preparing a ^{99m}Tc–sulfur colloid formulation that contains disodium edetate. Multivalent cation contaminants, such as Al^{3+} and Fe^{3+}, were chelated by the disodium edetate; formation of a flocculent precipitate was thus prevented. When prepared aseptically, the ^{99m}Tc–sulfur colloid is suitable for intravenous administration as a liver-scanning agent. The ^{99m}Tc–eluate must be added to an acidified sodium thiosulfate reaction solution, heated at 100°C for approximately 10 min, and neutralized with a buffer solution. Distribution studies of the ^{99m}Tc–sulfur colloid in the rat showed a rapid clearance of radioactivity from the blood stream and a subsequent rapid increase of radioactivity in the liver, to approximately 88% of the injected dose. The remainder of the radioactivity was found in other tissues. No toxic reactions were observed in mice given intravenous doses of 20 ml of ^{99m}Tc–sulfur colloid/kg. (auth)

21531 USE OF ZIRCONIUM SULPHATE IN THE PREPARATION OF ^{113m}In AND ^{99m}Tc-LABELLED ALBUMIN MACROAGGREGATES. Chapman, C.; Lonsdale, M. D.; Hayter, C. J. (General Infirmary, Leeds, Eng.). Int. J. Appl. Radiat. Isotop.; 21: 679-81(Nov 1970).

Owing to the dissatisfaction with compounds suitable for lung scanning due mainly to variation in particle size, agents effecting the denaturation of human serum albumin (HSA) were investigated. The effects of varying zirconium sulphate concentration between 0.5 and 5.0 mg/ml, varying pH between 2.5 and 11; and of heating in a boiling bath and of autoclaving at 15 psi were studied. Particle sizes produced under different conditions were compared with those particle preparations which had been found to give satisfactory lung localisation. The optimum pH was found to lie between 5.5 to 7.0 and the optimum concentration of zirconium sulphate was 1 mg/ml. The addition of zirconium sulphate did not significantly alter the relationship between the binding of ^{113m}In to the HSA-macroaggregates and the pH. The preparation of ^{113m}In and ^{99m}Tc macroaggregates is described, and the addition of zirconium in the preparation of HSA macroaggregates was found to ensure the consistent production of suitable particles. The advantages of these methods for the preparation of HSA macroaggregates are considered and the preparation of advance kits suggested. (UK)

21532 IN-VITRO THYROID TESTS IN CHILDREN. Murray, I. P. C.; Joasoo, A.; Parkin, J. (Prince of Wales Hospital, Sydney). Med. J. Aust.; 1: No. 2, 77-9(9 Jan 1971).

Serum total thyroxine (T_4) estimations have been performed for 180 children, for 131 of whom the triiodothyronine-resin uptake (T_3 resin) was also estimated. In children aged under 12 years, the serum T_4 value was frequently higher than normal adult values, and the T_3 resin slightly lower. Appropriate ranges of normality have, therefore, been calculated. These values appear to be the result of a higher thyroxine-binding globulin capacity in these children than in adults. After the introduction of the estimation of serum total thyroxine as a routine diagnostic investigation, it became apparent that values above the adult normal range were frequently being observed in children in whom there was no evidence of thyroid disease. The study reported here was, therefore, performed in order to obtain normal ranges for in-vitro tests of thyroid function in children. (Australia)

21533 RADIOACTIVE ^{14}C ACCUMULATION IN GLYCOGEN OF THE FISH LIVER. Yel'tishcheva, I. F. Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 69: No. 2, 28-33(1970). (In Russian).

Studies were made on uptake of radioactive sodium carbonate compounds by liver glycogen in fish. The amount of uptake was compared using carp, frogs, pigeons, and rats. Highest amounts were found in carp, less in frogs, and least in rats. The content of radioactive glycogen in carp could be increased by injecting adrenaline and glucose in addition to radioactive sodium carbonate. Under these conditions, the radioactive glycogen per 100-g live weight of carp was nine times higher than that of rats. (R.V.J.)

21534 AUTORADIOGRAPHY IN HUMAN CYTOGENETICS. Miller, Orlando J. (Columbia Univ., New York). Advan. Hum. Genet.; 1: 35-130(1970).

Methods for the preparation of radioautograms are reviewed. Applications of autoradiography in human cytogenetic studies are discussed with emphasis on quantitative and statistical aspects. It is pointed out that thymidine is an almost specific precursor of DNA, while uridine is present only in RNA, but is partially converted to cytidine within cells and can therefore be incorporated in both DNA and RNA. The uses of ^{3}H-5-uridine, ^{3}H-cytidine, and ^{3}H-thymidine as tracers for timing the synthesis of DNA and RNA at various times during the cell cycle, the characterization of chromosomes by their labeling patterns, as a means of comparing the DNA content of specific chromosomes, in determining the functional significance of DNA replication patterns, in studies on the regulation of gene action, and in studies on chromosome duplication and segregation are discussed. (298 references.) (C.H.)

21535 EXCHANGEABLE POTASSIUM IN MAN USING A NEW RADIOISOTOPE ^{43}K. Zollinger, Robert M.; Van DeWater, Joseph M.; Maletskos, Constantine J.; Moore, Francis D. (Peter Bent Brigham Hospital, Boston. Harvard Medical School, Boston. New England Deaconness Hospital, Boston). Surg. Forum; 21: 213-15(1970).

From 26th Annual Sessions of the Forum on Fundamental Surgical Problems, 56th Clinical Congress of the American College of Surgeons, Chicago, Ill. See CONF-701014.

A new isotope, ^{43}K, with a half-life of 22.6 hr was followed for 160 hr to determine body exchangeable K in a human subject. Following intravenous injection of ^{43}K there was rapid equilibration between serum, urine, and saliva. The constant specific activity after 40 hr implied complete equilibration of exchangeable K except for the remaining 1% within the red blood cells. Intracellular K within the RBC's slowly exchanged with plasma ^{43}K and required 90 hr for complete equilibration. The results proved that no large compartment or pool of partially bound, slowly exchanging K existed within the body. The longer half-life of the new isotope permitted complete equilibration in all body compartments and demonstrated significantly improved physical characteristics in dilution studies over those of ^{42}K. (E.E.H.)

21536 MEASUREMENT OF PLASMA ALDOSTERONE BY RADIOIMMUNOASSAY. Bayard, Francis; Beitins, Inese Z.; Kowarski, Avinoam; Migeon, Claude J. (Johns Hopkins Hospital, Baltimore. Johns Hopkins Univ., Baltimore). J. Clin. Endocrinol. Metab.; 31: 1-6(Jul 1970).

A radioimmunoassay for the measurement of plasma aldosterone is described. Aldosterone-3-carboxymethoxime-18,21-diacetate was coupled with rabbit albumin and antibodies produced in rabbits. Five to 20 ml of plasma, with 1,2-^{3}H-aldosterone added for recovery, was extracted and purification achieved by one paper chromatography. After 20 min incubation of the antibody-steroid mixture at 37 C, bound and free fractions were separated using Florisil. The mean recovery of ^{3}H-aldosterone, after extraction and chromatography, was 66.3 ± 13.6 (SD)%. The specificity of the method was confirmed by comparing the results obtained with those of the double isotope derivative method on the same plasma samples. The nonspecific blank was 0.088 ± 0.055 ng/sample (mean ± SD). A linear relationship between amounts of aldosterone measured and the size of the samples confirmed accuracy. Coefficients of variation of 14, 13.2, and 10.5% were obtained at levels of 4, 18, and 51 ng of aldosterone/100 ml of plasma. Results on normal individuals were comparable to those in the literature. (auth)

21537 CELL CYCLE CHARACTERISTICS OF HUMAN SOLID TUMORS IN VIVO. Young, Robert C.; DeVita, Vincent T. (National Cancer Inst., Bethesda, Md.). Cell Tissue Kinet.; 3: 285-90(Jul 1970).

The duration of the DNA synthesis phase of solid tumors in six patients was determined in vivo by local injections of tritiated thymidine into tumor nodules on the skin and serial biopsies of the lesions. Labeled mitosis curves constructed from the data ob-

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tained revealed a distinct wave of labeled mitoses but no evidence of a second wave of DNA synthesis in all six patients. The duration of S phase was 24, 22, and 24 hr in the three patients with malignant melanomas and 19, 22, and 24 hr in the three patients with breast cancer. The method is relatively simple and requires much lower doses of tritiated thymidine; reproducible data are obtainable in patients with solid tumors in a much shorter period of time than with previous experiments. (auth)

21538 IZOTOPY V BIOLOGII I MEDITSINE. (Isotopes in Biology and Medicine). Grodzenskii, D. E. Moscow: Atomizdat (1969). 208p.

The value of tracer techniques (use of labeled atoms) in modern science is noted and the applications of these techniques to solve such problems as the origin of life on earth, the mechanisms of photosynthesis and protein synthesis, and the unraveling of the genetic code are illustrated. The role of tracers in studies of the exchange, penetration, and absorption of substances in man and animals, in investigations of drugs and toxins, and in other problems of experimental medicine is also discussed. New diagnostic methods are described using radioisotopes and modern scanning equipment, and examples are given of the use of radioisotopes in therapy. The book is intended for a wide range of readers, and is of equal interest to biologists, physicians, students, post-graduate specialists, and secondary school teachers. (tr-auth)

21539 MEASUREMENT OF GASTRIC EMPTYING USING THE SCINTILLATION CAMERA AND ^{129}Cs. Jones, B. T. (Hammersmith Hospital, London); Clarke, J. C.; Kocak, N.; Cox, A. G.; Glass, H. T. Brit. J. Radiol.; 43: 537-41(Aug 1970).

A simple technique was presented for directly measuring gastric emptying using an Anger scintillation camera in conjunction with readily available nucleonic equipment. Cyclotron-produced ^{129}Cs is the radioisotopic marker that is mixed with the patient's meal. It has a 32.1 hr half-life and principally emits 370 and 410 keV photons, which provide a half-value thickness in tissue of 9.3 cm. The ^{129}Cs is bound to insoluble zirconium phosphate to prevent absorption from the stomach. Illustrations of the use of this method were given with normal subjects and patients after vagotomy. The step like emptying pattern of the stomach contents was sometimes apparent when this technique was used. The relative merits of the camera and the scanner for this type of study were discussed. (auth) (UK)

21540 LONG-LIVED γ-RAY EMITTING NUCLIDE ^{108m}Ag FOUND IN PACIFIC MARINE ORGANISMS AND USED FOR DATING. Folsom, T. R.; Grismore, R.; Young, D. R. (Scripps Institution of Oceanography, La Jolla, Calif.). Nature (London); 227: 941-3(29 Aug 1970).

Dried tissues of several marine organisms collected in 1964 from widely separated regions of the North Pacific were found to contain ^{108m}Ag, a γ-ray emitting man-made nuclide with a half-life reported to >100 yr. This appeared to be the first observation of this nuclide in any organism as the apparent result of global fallout. It promises to be useful for large scale labelling and dating, and was used to follow the progress of oceanic water masses. The activities of ^{108m}Ag found in samples of squid, mussel, lobster, tuna, and albacore are listed, together with some data for ^{110m}Ag. The dates of apparent nuclear origin implied by the activity ratios $^{110m}Ag/^{108m}Ag$ are also shown. An initial ratio of 162 was assumed in the dating computations, this being the value reported immediately after activation of natural Ag in a reactor and implying nearly equal activation cross sections for the production of the two nuclides. An important feature is that ^{108m}Ag has a life longer than any other man-made γ-emitter reported anywhere in the biosphere. The matter of how the organisms came into contact with the observed Ag nuclides is discussed, including environmental factors; it is concluded that these nuclides originated most likely during the 1961 and 1962 testing periods. A mechanism was suggested to explain how a trace element might be isolated and maintained pure effectively for several years in thin subsurface layers while moving thousands of miles, and also variations for different species of fish. No evidence of hazard to humans should be inferred from the finding of ^{108m}Ag in tuna and other fish; the activities were so small as to be difficult to detect. (UK)

21541 DETECTION OF LATENT FINGERPRINTS WITH $^{35}SO_2$. Spedding, D. J. (Univ. of Auckland, N. Z.). Nature (London); 229: 123-4(8 Jan 1971).

It has been reported that latent fingerprints on paper can be detected by autoradiography of the paper after treatment with $^{35}SO_2$. The present author also found that this technique can be applied to finely woven fabrics, and also investigated the type of compounds in the fingerprint deposits to which the SO_2 is bound. Indications were obtained that the labeled compounds are lipid in nature, including the unsaturated acids such as oleic and linoleic acids. The possibility of detecting latent fingerprints on paper which had been immersed in water was also investigated; some success was obtained with the $^{35}SO_2$ technique. (UK)

21542 DETERMINATION OF ^{14}C-LABELLED LIPIDIC FRACTIONS SEPARATED BY THIN LAYER CHROMATOGRAPHY. Nemec, Rudolf. Biologia (Bratislava); 25: 611-15(1970). (In Czech).

The method of ^{14}C-labelled lipidic fractions separated by TLC was found as suitable for routine analyses. Measuring error when determinating radioactivity of ^{14}C-labelled cholesterol and palmitic acid varied in range of 1.3 to 1.4%. The evaluation of ^{14}C-labelled lipidic fraction separated by TLC is recommended to carry out through the method of direct measurement, i.e., to scrape down the separated fraction together with silica gel into the scintillation vial, add methanol and scintillation solution SLT, and then perform the measuring. In the case when direct measuring is not possible, it will be necessary to repeat the extraction of the lipidic components from silica gel five times. (auth)

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Refer also to abstracts 21107, 21614, 21644–21646, 21649, 21658, 21662, 21684, 21710, 21726, 21836, 21859, 21871, 21891, and 21905.

21543 (AD-413791) EFFECTS OF X IRRADIATION ON THE BIOLOGICAL ACTIVITY OF COTTONMOUTH MOCCASIN (AGKISTRODON PISCIVORUS) VENOM. Flowers, Herschel H. (Army Medical Research Lab., Fort Knox, Ky.). 16 Aug 1963. 14p. (USAMRL-588). NTIS.

Studies were made to determine the effects of x irradiation on the lethality and local reactivity of cottonmouth moccasin venom. The local reactivity of the venom was reduced 50 to 65%. The lethal effect was markedly decreased. It took almost six times the weight of lyophilized x-irradiated venom to produce the mouse LD50. Immunoelectrophoresis and immunodiffusion demonstrated little difference in the pattern of antigens of x-irradiated and normal venom. Additional investigation is necessary to thoroughly evaluate the use of x irradiation in the toxoiding of venoms. Studies of antisera prepared by injection of x-irradiated venom into experimental animals are underway. The capability of those antisera to neutralize local effects and lethality is significant and encouraging. (auth) (USGRDR) (TSS)

21544 (AD-464714) CHANGES IN ^{137}Cs RETENTION AND ROUTES OF ELIMINATION AS EFFECTED BY EXTERNAL FACTORS. McPeak, Dailey W.; Lodde, Gordon M.; Parr, Wordie H. (Army Medical Research Lab., Fort Knox, Ky.). 7 Jan 1965. 9p. (USAMRL-617). NTIS.

Investigations were made to determine the roles that cold and x irradiation played upon the biological half-time of ^{137}Cs in rats. Partial and whole-body x irradiation increased the biological half-time of ^{137}Cs while cold, with the associated increased food consumption and fluid exchange, decreased the biological half-time. Analysis of fecal and urine outputs showed that increased diuresis did not invariably facilitate ^{137}Cs excretion. The possible roles of food ingestion and fecal outputs are discussed. (auth) (USGRDR)

21545 (ANL-7760(Pt.2), pp 22-34) SKELETAL CONCENTRATIONS AND METABOLIC PARAMETERS OF ^{210}Pb AND ^{226}Ra IN RADIUM-BURDENED PEOPLE. Holtzman, R. B. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969–June 1970.

The concentrations of ^{226}Ra and its decay product, ^{210}Pb, were determined in 44 bone samples taken from 13 persons who had acquired the radium either as dial painters or during medical treatment. The whole-body burdens, carried four to 36 years, ranged from 0.4 to 10 μCi ^{226}Ra. The ^{210}Pb was derived almost entirely from the radium in bone, an assumption supported by measurements on radium-injected dogs with short-term exposures of seven to 500 days. Despite great differences from sample to sample, such as differing body burdens, exposure times, and methods of acquisition, differing bone types (femur, rib, vertebra, etc.), and large differences in ^{226}Ra concentration (10^2 to 10^4 pCi/g ash), the ratios of ^{210}Pb specific activities to those of ^{226}Ra were fairly uniform, with an average of 0.34 ± 0.03 (S.E.). This uniformity and the large variations in radium concentrations within an individual (factors of 10 or more) indicate either that the ^{226}Ra and ^{210}Pb were metabolized similarly, or that little ^{210}Pb was translocated from the site of formation. That some translocation may occur is shown by the high ratios of 1.6 to 30 in some samples. The low values of ^{226}Ra in these specimens relative to those in other samples from

the same subject may indicate that little radium was taken up initially. The effective half-life of the ^{210}Pb, based on the ^{210}Pb-to-^{226}Ra ratio of 0.34, appears to be about half that of the radium in an exponential retention model. The dose from the $^{210}Pb(^{210}Po)$ series appears to be about 10% of that of the ^{226}Ra series over the period of 10 to 40 years after acquisition. (auth)

21546 (CONF-700816-(Vol.2), pp 721-37) DYNAMIC SIMULATION OF THE RETENTION AND TRANSLOCATION OF INHALED PLUTONIUM OXIDE IN BEAGLE DOGS. Stuart, Bruce O.; Dionne, Paul J.; Bair, William J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

A dynamic simulation model for the biological disposition of inhaled plutonium oxide was developed using hybrid computer techniques. Tissue, blood, and excretion data collected from more than 60 beagle dogs up to 8.5 years after single inhalation exposures to $^{239}PuO_2$ were incorporated into a program that predicts the long-term retention and translocation of inhaled insoluble plutonium. The dynamic simulation fitted to the accumulated data shows 10% of the plutonium initially deposited in the pulmonary lung remains at 12 years after exposure; the majority of this material follows a 4-year retention half-time. At 15 to 20 years after exposure the tracheobronchial lymph nodes, liver, and skeleton burdens plateau at 55%, 16%, and 6% of the plutonium deposited in the pulmonary lung. (auth)

21547 (EUR-4548) ACUTE HEPATIC TOXICITY OF ORGANIC REACTOR COOLANTS. Ott, H.; Pirrwitz, D. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 10 Feb 1970. 14p. Dep. NTIS (U. S. Sales Only). EUR Fr.F. 4.45.

Liver function in rats after ingestion of single doses of the organic reactor coolants OM-2, DOM, THERMIP, and HB-40 and their main components o-terphenyl, m-terphenyl, diphenyl, 1-methylnaphthalene, and 2-methylnaphthalene, was assessed by the sulfobromophthalein (BSP) retention test. Liver function was moderately impaired after ingestion of 1.5 g/kg body weight of OM-2 and DOM, and of 2.0 g/kg THERMIP during the first two days after ingestion, while HB-40 produced no effect. Among the pure compounds, o-terphenyl and 1-methylnaphthalene produced the strongest effects. In all cases normal liver function was restored after three to five days. (auth)

21548 (TID-24270, pp H,167-76) FALLOUT RADIOACTIVITY AND EPIPHYTES. Odum, H. T. (Puerto Rico Nuclear Center Rio Piedras); Briscoe, George Ann; Briscoe, C. B. (Forest Service, Rio Piedras, Puerto Rico. Inst. of Tropical Forestry).

From Tropical rain forest.

After relatively high levels of fallout retention were discovered in the epiphytic mossy forest of the Luquillo Mountains during 1962, a survey of the distribution of radioactivity in the rain forest system was made with β counting of 1500 samples supplemented with γ spectra. High levels, up to 4138 counts per minute per gram, were found mainly in or on green plant tissue and the derived litter, with as much variability among leaves of the same tree as between trees. The degree of uptake was correlated with epiphytic mode of growth, with algae moss liverwort encrustations highest, massive mosses second, bromeliads third, and rooted plants last. The radioactivity in leaves was found to be in proportion to the epiphytic growth on the leaves and thus was related to their age. Gamma spectra were similar in most materials including leaves of many tree species, litter, termite nest, and the roof algae near San Juan. (auth)

21549 (TID-24270, pp H,181-6) COMPARISONS OF THE AMOUNTS OF FALLOUT RADIONUCLIDES IN TROPICAL FORESTS. Kline, J. R.; Odum, H. T. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Leaves and forest litter were collected from 10 tropical forests in Puerto Rico, Dominica, Trinidad, and Central America for analyses of fallout radionuclide content. Measurements were made by γ scintillation spectrometry for ^{144}Ce, ^{137}Cs, and ^{54}Mn. Highest levels of these isotopes were found in the northernmost tropical forests at the highest elevations above sea level. The amounts of contamination showed a general decrease with decreasing latitude. Forests at the same latitude were contaminated in relation to the mean annual rainfall at the sampling site. Individual species within a given forest showed wide variations in the levels of contamination, but, in general, plants with an epiphytic growth habit were more heavily contaminated than the surrounding tree species. Comparisons of leaves and forest litters indicated an apparent accumulation of ^{144}Ce and ^{54}Mn, but not of ^{137}Cs, in the litter of all forests examined. All forests except one showed detectable but low-level amounts of $^{95}Zr-^{95}Nb$ in both leaves and litters. The one exception, a forest in Mexico, showed an average of 3.5 picocuries/g in the leaves and 10.3 picocuries/g in the forest litter. Levels of ^{144}Ce, ^{137}Cs, and ^{54}Mn were not correspondingly high in this forest. Fresh fission products, such as ^{131}I, $^{140}Ba-^{140}La$, and ^{103}Ru, were not found. (auth)

21550 (TID-24270, pp H,191-7) RETENTION OF FALLOUT RADIONUCLIDES BY TROPICAL FOREST VEGETATION. Kline, J. R. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Freshly fallen leaf litter and live-leaf samples pruned from trees were collected monthly at the El Verde experimental site for measurement by scintillation spectrometry of γ emitting radionuclides of stratospheric origin. Input of radionuclides during the period of the collections was below the detection limits of the measuring technique. The objective of the collections was to measure the biological half-times for retention of four nuclides in tropical forest vegetation. The nuclides measured were $^{95}Zr-^{95}Nb$, ^{144}Ce, ^{137}Cs, and ^{54}Mn. The average effective half-times for $^{95}Zr-^{95}Nb$, ^{144}Ce, ^{137}Cs, and ^{54}Mn were 120, 228, 450, and 250 days, respectively. The environmental half-times computed from these data were doubling time of 141 days for $^{95}Zr-^{95}Nb$, 1140 days for ^{144}Ce, 469 days for ^{137}Cs, and 1230 days for ^{54}Mn. The doubling time for $^{95}Zr-^{95}Nb$ indicates a continuing input of this nuclide into the El Verde forest. Because ^{137}Cs has the longest physical half-life, its environmental half-life can be most precisely determined; the estimates for the other nuclides are less reliable. The data show that some of the nuclides were partially incorporated into the forest mineral cycle. The nuclide least involved in cycling was ^{137}Cs. (auth)

21551 (TID-24270, pp H,201-4) MOVEMENT OF ^{85}Sr AND ^{134}Cs BY THE SOIL WATER OF A TROPICAL RAIN FOREST. Jordan, C. F. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Radioactive strontium and cesium were used to tag waters applied to rain forest plots under which were located lysimeters at litter level and at a 5-in. depth within the mineral soil. After 6 months only 33% of the strontium and 27% of the cesium had moved out of the litter. Less than 1% of each had reached the deeper lysimeters. Changes in the rate of release of these elements with time suggest the effectiveness of the litter layer in retaining minerals. (auth)

21552 (TID-24270, pp H,205-9) PRELIMINARY STUDIES OF RADIONUCLIDE CYCLING IN UNDERSTORY PLANTS IN THE RAIN FOREST. Kline, J. R.; Mercado, Nelson (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

An experiment was carried out in the understory of the El Verde rain forest to determine the fate of several radionuclides applied to the forest floor in water-soluble carrier-free form. To each of four plots ^{134}Cs, ^{85}Sr, and ^{54}Mn were applied at rates of about 1 mc/m^2. Small leaf samples from the plants on each plot were collected periodically for one year; the experiment was then terminated by completely harvesting all plant material. Uptake by plants was extremely slow for all the nuclides of this experiment. The harvested plant material showed that in one year less than 1% of the ^{134}Cs and ^{54}Mn was taken up by the plants. Soil samples showed that in excess of 90% of the ^{134}Cs remained in the surface 3-in. layer after 18 months and that from 2 to 9% was in the organic surface litter. It was concluded from the slow movement of nuclides that the El Verde forest was not in a steady state with regard to turnover of its burden of fission products. The experiment supports the hypothesis that fission products in vegetation of this forest are the result of their interception and retention on leaf surfaces. (auth)

21553 MEASUREMENT OF ^{210}Pb (RaD) IN THE HUMAN BONE AT BOMBAY, INDIA. Khandehar, R. N.; Anand, S. J. S. (Bhabha Atomic Research Centre, Trombay, India). Health Phys.; 20: 83-5(Jan 1971).

The method of analysis of ^{210}Pb in the human bone at Bombay during 1960 to 65 is reported. The distribution in the skeleton (skull, ribs, vertebrae, long bones) is tabulated. The data show that on the average the maximum concentration was in the ribs (0.404 pCi/g of ash) and the least was in the long bones (0.092 pCi/g of ash). These results are compared with comparable ^{90}Sr results. The yearly average concentrations of ^{210}Pb in bones in the period are considered. Since 1961 there has been an increase of almost three. The possible reasons for this are considered. (UK)

XUM

21554 APPROACH TO THE CALCULATION OF THE ALLOWABLE SPECIFIC ACTIVITIES IN MARINE FISHES. Sarma, T. P.; Krishnamoorthy, T. M.; Sastry, V. N. (Bhabha Atomic Research Centre, Bombay). Health Phys.; 20: 23-30(Jan 1971).

A mathematical expression is given by ISAACS et al. (1962) for calculating the specific activity in fish using an assumed exponential growth equation. In the present work, experimentally verified limited growth cubic equation proposed by Von Bertalanffy 1934 is used in place of the exponential growth equation of Isaacs'. Further, assuming an age distribution function of the type $n = \alpha te^{-at}$ which is found to be applicable for the actual fish catches along the Indian coast, an expression is derived for the weighted average specific activity in fishes in an actual catch. There is a good agreement between the values calculated from the model proposed here and Isaacs' expression for nuclides having short physical and/or biological half-lives. However, for nuclides having long physical and biological half-lives (e.g., ^{45}Ca, ^{55}Fe, and ^{90}Sr), the values from the present model are significantly higher than Isaacs' limiting values and approach Isaacs' limiting values only at infinite age of the fish. (auth) (UK)

21555 DYNAMICS OF ^{137}Cs ABSORBED WITH FOOD IN A FRESHWATER FISH. Baudin, J. P. (CNRS, Paris); Foulquier, L.; Bovard, P. Compt. Rend. Hebd. Seances Acad. Agr. Fr.; 56: 662-9(1970). (In French).

A study of the ^{137}Cs distribution variations in catfish showed that this radioelement absorbed with food remained only a short time in the digestive tube. A few days after consumption of the contaminated food, 10% of the radioactivity is found in the skin and skeleton and 70% in the muscles. The other organs and tissues are only involved in transit processes. (France)

21556 FUNCTIONAL EXPLORATION OF A PIG USING RADIOELEMENTS. ^{131}I AND THE THYROID FUNCTION. Daburon, F.; Grillon, G. (CEA, Jouy-en-Josas, France). Rev. Med. Vet. (Toulouse); 121: 793-808(1970). (In French).

The thyroid function, particularly hypothyroidism can be easily estimated with pigs. A possibility might exist for selecting the physiological characteristics suitable in breeding. (France)

21557 SIMPLE, RELIABLE METHOD FOR PRODUCING HYPOTHYROIDISM IN THE DOG AND THYROID FUNCTION TESTS IN NORMAL AND HYPOTHYROID DOG. DiScala, Vincent A.; Lippe, Richard D.; Segal, Robert L. (Public Health Service Hospital, Staten Island, N. Y. Mount Sinai Medical School, New York). Endocrinology; 88: 504-6(Feb 1971).

Hypothyroidism is a common and generalized disorder which is seen in both animals and man. Although it can be easily produced experimentally in the rat, it is difficult to produce in the dog. We have evaluated various techniques used to induce this disorder in the dog, and present a new reliable method which is a modification of the use of ^{131}I. Surgical thyroidectomy was unsuccessful and small doses of ^{131}I with prior TSH stimulation with and without previous surgical thyroidectomy were unreliable. The administration of large doses of ^{131}I (2 mCi kg) following TSH stimulation produced hypothyroidism in all attempts. The radioactive iodine uptake of the thyroid gland, triiodothyronine resin uptake and serum cholesterol were reliable determinants of thyroid function and were significantly different in the normal and hypothyroid dogs. In addition, the serum cholesterol was found to be useful in following the dog's thyroid state during therapy. (auth)

21558 BIOSYNTHESIS OF TISSUE PROTEINS IN RATS DURING INTERNAL USE OF RADON WATER. Roitblat, L. M. Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 34: 401-4(Sep-Oct 1969). (In Russian).

The effects of radon on nitrogen-protein metabolism in animals were studied using white rats weighting 180 to 220 g and treated per os with the natural curative water (containing 0.18 $\mu c/l$ Ra) and with artificially prepared water (36.4 $\mu c/l$ Ra) for 20 days. On the 21st day the rats were injected intraperitoneally with a labeled aminoacid-methionine ^{35}S. Data obtained revealed a slowed-down rate of methionine-^{35}S incorporation into tissue proteins in various organs (except the liver) in animals treated with the high-radon content water while in the animals treated with low-randon water no changes were observed in the rate of methionine-^{35}S incorporation into protein. The results may be used as an indication of the biological effect of radon water. (R.V.J.)

21559 BIOCHEMISTRY OF MEMORY RETENTION. I. EFFECTS OF HEAVY WATER ON MEMORY IN FISH. Lehr, E.; Wenzel, M.; Werner, G. (Max-Planck-Institut fuer Hirnforschung, Frankfurt am Main, Freie Univ., Berlin). Naturwissenschaften; 57: 521-4(Nov 1970). (In German).

Fish were trained to discriminate between red and green lights. After training one group was kept in normal water and the other in normal water with a content of 12.5% or 25% heavy water (D_2O), and retention of the learned discrimination was compared in both groups. Significantly ($p > 0.01$) more correct responses to the previously learned color were recorded for fish in the heavy water mixture. This better memory retention may be a result of making memory molecules more stable by replacing their H-bondings by D-bondings. (auth)

21560 RELATIVE TRANSLOCATION AND DISTRIBUTION OF Pu AND Am FROM EXPERIMENTAL PuO_2 SUBCUTANEOUS IMPLANTS IN BEAGLES. Johnson, LaMar John. Fort Collins, Colo.; Colorado State Univ. (1969). 244p. University Microfilms Order No. 70-15,181.

Thesis.

Estimating plutonium burdens by in vivo measurement of the 59.5 keV ^{241}Am gamma ray has been a widespread practice in the nuclear industry. The assumption that plutonium and americium are identically metabolized within the biological system has been the basis for this procedure. A study of simulated puncture wounds in forty beagle dogs contaminated with PuO_2 provided data on the relative translocation and distribution of Pu and Am. Half of the dogs were given chelation therapy with the trisodium calcium salt of diethylene triaminepentaacetic acid (DTPA). The first major lymph node draining the implant site collected a significant fraction of the implanted material. The kinetics of the lymph node activity accumulation were studied by in vivo measurement. Empirical equations describing the activity buildup were derived. About 10% of the node burden was accumulated in the first two days. Pu/Am activity ratios served as indices of the relative concentration or retention within each type of sample. The experimental animals were serially sacrificed for tissue sample collection and radiochemical assay. Relative enhancement of Am concentration was found in the reticuloendothelial tissues, the major Pu and Am concentrating soft tissues. Relative enhancement of Pu concentration was general in skeletal tissue. The magnitude of the enhancement increased with the blood cell forming activity of the bone. The disintegrations per minute per gram in the thyroid gland was low, but the relative Am enhancement was the largest of all the tissues. Administration of DTPA increased the relative Pu/Am ratio in urine, femur, and liver tissue. These samples from DTPA treated dogs showed increases of 2, 3, and 5 fold, respectively, in the Pu/Am activity ratio. The data showed differential translocation and excretion of Pu and Am. Consideration of the relative metabolism of these elements in interpreting in vivo estimations of Pu burdens via Am measurement is needed. (Diss. Abstr. Int., B)

21561 RELATIONSHIP OF ^{137}Cs AND ^{59}Fe ELIMINATION RATES TO METABOLIC RATES OF SMALL RODENTS. Baker, Charles Edwin. Knoxville, Tenn.; Univ. of Tennessee (1970). 117p University Microfilms Order No. 70-20,294.

Thesis.

Elimination of ^{137}Cs and ^{59}Fe by wild small rodents was measured in the laboratory and field to determine whether excretion rates of these nuclides are influenced directly by general metabolic rates. The object of this research was to establish a technique for measuring metabolism in the field for ultimate application in energy flow studies. A double-tagging method was employed, isotopes were administered intraperitoneally, and attention was focused on final-component elimination of each isotope. Cotton rats (Sigmodon hispidus), harvest mice (Reithrodontomys humulis), and white-footed mice (Peromyscus leucopus) were used in laboratory investigations, and cotton rats and white-footed mice were employed in field experiments. Isotope elimination studies in the field were conducted in winter and spring, assuming that metabolic rates of rodents would be higher in winter due to lower temperatures. Average daily metabolic rates in the laboratory were determined by measuring carbon dioxide production with an infrared analyzer, and were examined in conjunction with ^{137}Cs and ^{59}Fe excretion rates. Animals were maintained under different experimental conditions, which were designed to create metabolic rate alterations. Both species in field studies eliminated ^{59}Fe more rapidly than laboratory animals, but only cotton rats excreted the isotope faster in winter than in spring. No differences between ^{137}Cs seasonal excretion rates of either species were found, and field values did not differ from those obtained in the laboratory. There was, however, a striking difference between species in rate of ^{137}Cs turnover, with Peromyscus excreting the isotope about twice as fast as Sigmodon. Rate of long-component ^{137}Cs loss from rodents was not affected by metabolic rate changes at any treatment level; but, as in the field experiment, interspecific differences were noted in ^{137}Cs elimination rates, and also in metabolic rates. Although ^{59}Fe elimination appeared to correlate with metabolic rates in the field, laboratory experiments

failed to demonstrate a predictable relationship between excretion of this nuclide and general metabolism. (Diss. Abstr. Int., B)

21562 FLUCTUATIONS OF SUGAR LEVELS IN BLOOD AND HEPATOPANCREATIC TISSUE OF GAMMA-IRRADIATED NILE FISH, TILAPIA NILOTICA. Roushdy, H. M.; El-Kashef, H. S. (Atomic Energy Establishment, Cairo). Isotop. Radiat. Res.; 3: 49-55(Jun 1970).

Whole-body γ irradiation of Tilapia nilotica at the dose levels of 500 and 1000 rads resulted in marked initial hyperglycemia that was more intensive after the higher radiation dose. Later, recovery was gradually attained and was followed by prolonged hypoglycemia. There was also decreased level of free reducing sugars in hepatopancreatic tissue. The initial hyperglycemia was possibly due to increased adrenalin secretion, while the subsequent hypoglycemia may be due to retarded absorption of carbohydrates from the intestine, leading to the absence of materials required for glycogenesis in blood circulation. The decreased level of free reducing sugars in hepatopancreatic tissue can be attributed to an increasing tendency for free sugars to escape into blood circulation, or to be utilized in the biosynthesis of glycogen. (auth)

21563 EFFECT OF DISSOLVED-IN-WATER RADIOISOTOPES ON THE FISH ROE DURING EMBRYONIC DEVELOPMENT. Shekhanova, I. A.; Bel'makov, V. S.; Lapin, V. I.; Lyashenko, A. G.; Miloradov, G. K. Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 69: No. 2, 34-48 (1970). (In Russian).

Studies were made on the effects of radioisotopes in water on embryogenesis in the fish, Neoglobius metanostomus, Salmo irridens, and Oncorhynchus gorbuscha. Solutions containing maximum permissible doses of ^{89}Sr, ^{90}Sr, and ^{90}I were used for experiments carried out in open basins. Strontium preparations were used without a stable carrier. During incubation of the eggs, an increase was observed in the amount of RNA, oxygen consumption, and the amount of hemoglobin in the blood stream. It was impossible to observe the influence on morphological development. (R.V.J.)

21564 SOME ASPECTS OF THE UPTAKE AND CONVERSION OF ^{35}S-SULFATE TO THE ORGANIC FORM IN PLANTS. Holobrada, Margita (Botanical Inst., Bratislava). Biologia (Bratislava); 25: 667-71(1970).

While growing peas in full nutrient solution with addition of $Na_2{}^{35}SO_4$, the dynamics of the ^{35}S-sulfate in different organs of the pea and the incorporation of ^{35}S in free organic compounds were followed. The inorganic form of ^{35}S in the pea seeds is already present on the first day of the experiment. After the piercing of the seed coat by the radicle the presence of free organic S-compounds was also demonstrated. At first, in the roots, an accumulation of ^{35}S-sulfate, which was incorporated in free organic compounds after the third day of the growth of the roots, was noted. In the above-ground organs ^{35}S-sulfate, in this way as in the roots, was incorporated in organic compounds after a previous accumulation. (auth)

21565 POSSIBILITY OF USING ^{89}Sr FOR A MASS LABELLING OF YOUNG FOOD-FISHES. Shekhanova, I. A. Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 69: No. 2, 58-69(1970). (In Russian).

Metabolism of ^{89}Sr in carp and sturgeon was studied in order to determine the possibility of using ^{89}Se as a tracer in mass labelling of fish. It was found that the young sturgeon accumulates a sufficiently large amount of ^{89}Sr from the water. Moreover, the amount of the uptake depends on the age and size of the sturgeon, isotopic concentration in the water, and the length of the exposure of the fish in the solution. The most convenient method of labeling the fish was found to be by feeding them with labelled food (oligochaetes or larval chironomids). The labelling by ^{89}Sr is retained for 7 to 8 months which is much longer than the labelling with ^{32}P, and is recorded more easily than ^{45}Ca. It is suggested that ^{89}Sr is more effective for mass labelling the fish on an industrial scale. (R.V.J.)

21566 TENTATIVE RESULTS ON ESOPHAGEAL SCANNING. Lahneche, B. E.; Pierluca, P. (Centre de Lutte Contre le Cancer Leon Berard, Lyon). J. Radiol., Electrol., Med. Nucl.; 51: 659-64(Nov 1970). (In French).

The use of scanning using ^{197}Hg-mercury bichloride is of value in the study of esophageal carcinomas because of its innocuousness, the simplicity of making repeated scans, and the high statistical probability of neoplasm detection, including metastatic foci which were not detected during clinical and radiological tests. Three negative results were obtained out of nineteen carcinomas, with no false positive results. The method has until now been used only on carcinomas in an advanced state and it is not possible to give an opinion on the limits of detection of primary carcinomas; this is dependent on their size. An additive picture of the tracer at the mediastinal level is not characteristic of an esophageal carcinoma. (France)

21567 EFFECT OF PROLONGED STARVATION ON THE FUNCTION OF THE BLOOD-BRAIN BARRIER IN DOGS. Yaromenka, S. A. (Inst. of Medicine, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 5, 88-94(1969). (In Belorussian).

The condition of the tissue-blood barriers in dogs subjected to prolonged water starvation was studied. It is apparent from the experiments that most of the ^{76}As disappears from the circulatory system of animals during the first 15 min. Maximum quantities of the radioisotope were found in the cerebrospinal fluid during the first 60 min, and in the internal organs during the first 3 hr of the experiment. Prolonged starvation resulted in a disturbance of the protective function of the tissue-blood barriers. The internal organs, listed according to decreasing radioactivity at 3 hr, were: liver, lungs, kidney, spleen, small intestine, large intestine, heart, muscle, and skin. Brain tissues, listed according to decreasing radioactivity at 3 hr, were: hypophysis, cerebral cortex, medulla oblongata, cerebellum, white matter of brain, and spinal cord. (tr-auth)

21568 RADIOISOTOPE UPTAKE BY SELECTED RANGE FORAGE AND WEED SPECIES. Eckert, Richard E. Jr.; Blincoe, Clifton R. (Univ. of Nevada, Reno). J. Range Manage.; 23: 367-9(Sep 1970).

Two wheatgrasses, one annual grass, and one annual forb were used to evaluate the uptake of fourteen γ emitting isotopes from an important range soil. Uptake of copper, molybdenum, and selenium ranged from moderate to very good from all soil horizons. Uptake of iodine and chromium was poor from the surface and lower soil horizons, respectively, but moderate to very good from other horizons. Other desirable characteristics of these isotopes for root-tracing studies are half-lives of from 12.8 hours to 128 days, and energy differences that permit detection of each isotope in the presence of others. (auth)

21569 PREVENTION OF UPTAKE OF ^{137}Cs BY LAYING-HENS. Nezel, K. (Bundesforschungsanstalt fuer Kleintierzucht, Celle, Ger.). Z. Lebensm.-Untersuch. Forsch.; 144: 25-31(Sep 1970). (In German).

Presaturation of the organism of Leghorn-hens by inactive cesium has no influence upon the ensuing uptake of ^{137}Cs. Isotope dilution of radioactive ^{137}Cs by inactive Cs does not diminish the incorporation of the radionuclide. The enhancement of the excretion of ^{137}Cs in hens by $NH_4Fe^{3+}[Fe^{2+}(CN)_6]$ is not very important. The effective half-life is only shortened about 20%. But this substance is able to inhibit nearly completely the uptake of ^{137}Cs when given together with the contaminated food. Eggs as well as meat contained almost no ^{137}Cs although the food contained 15 nCi/kg of the radionuclide. (auth)

21570 TOXICOLOGY OF RADIOACTIVE ^{65}Zn. Kurlyandskaya, E. B. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 1-11(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 1-11(1965).

Zinc-65 was administered orally to rabbits in various concentrations. Several problems concerning the biological effects of radioactive zinc were studied, including metabolism, effects on hemopoiesis, cardiac activity and bioelectrical activity of the brain, and immune reactions. A summary of the results is given, and it is concluded that zinc-65 is a highly toxic radioisotope. (F.M.M.)

21571 BEHAVIOUR OF ^{65}Zn IN THE RAT BODY. Khristov, Kh. D. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 12-34(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 12-34(1965).

Soluble compounds of ^{65}Zn given in a single intratracheal and intraperitoneal dose were absorbed in the first 24 hr, whereas on subcutaneous administration absorption took a month. Soluble compounds of ^{65}Zn irrespective of the route of admission in the early stages tended towards relatively diffuse distribution with certain organ tropism. The highest specific activity was seen in the pituitary, liver, pancreas, suprarenals, testes, and adnexa. Elimination of ^{65}Zn from the body occurred in the main via the gastrointestinal tract with over 90 percent in feces and only about 8 percent in the urine. The biological half-life in the body for soluble compounds of ^{65}Zn was about 5 days. Complete elimination in rats occurred in 30 days. (auth)

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21572 DISTRIBUTION OF ^{65}Zn IN THE BODY OF RABBITS AND DOSES RECEIVED BY THEM ON CHRONIC ADMINISTRATION OF $^{65}ZnCl_2$ ORALLY. Avrunina, G. A. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 20-34(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 20-34(1965).

It is shown that with single administration of $^{65}ZnCl_2$ to rabbits about 40 percent of the activity introduced is absorbed from the gastrointestinal tract. Vital measurements of activity in the body of rabbits receiving daily $^{65}ZnCl_2$ orally at the rate of 10, 1 or 0.1 μCi/kg with stable carrier (0.1, 0.001, or 0.01 mg/kg) and the preparation without carrier at the rate of 1 μCi/kg show that 1.5 to 3 months after the start of the experiment a relatively constant level of activity is set up. The distribution of ^{65}Zn in rabbits receiving the preparation with carrier at the rate of 10 and 1 μCi/kg was of the same character. With increase in the amount of stable carrier in the solution there was some tendency for the equilibrium level of activity to fall in nearly all tissues but less distinct than in the case of chronic administration of ^{60}Co and ^{59}Fe. The greatest activity was observed in the liver, spleen, kidneys, and bones, while that of the blood was very low. Unlike the published findings for rats no selective high activity was found for bones. According to vital measurements the activity of the counters of the gastrointestinal tract reaches 35 to 40 percent of the total level of body activity. According to autopsy measurements this value was somewhat less. In both cases it was lower than in experiments with ^{60}Co and ^{59}Fe. After stopping administration of ^{65}Zn both with and without carrier the activity during one month fell by 30 to 40 percent apparently in the main due to elimination of that accumulated in the gastrointestinal tract. According to external measurements the mean specific activity in the body of newborn rabbits of does receiving ^{65}Zn with carrier exceeds 1.5 times the mean specific activity of the maternal body. The mean absorbed radiation doses in the body are for rabbits receiving $^{65}ZnCl_2$ with carrier at the rate of 10, 1 or 0.1 μCi/kg, 0.45, 0.043, and 0.0044 rad/day, respectively. In rabbits receiving the preparation without carrier this dose was 0.031 rad/day. The total doses for the whole period of the experiments reached 258, 20.7, 2.4, and 5.2 rad respectively that (taking into account the duration of the experiment) exceeds the maximum permissible dose (for occupational irradiation) by a factor of 30, 3, 0.3, and 1. (auth)

21573 EFFECT OF THE AMOUNT OF STABLE CARRIER ON THE LEVEL OF ACCUMULATION OF ^{65}Zn FOLLOWING DAILY ORAL ADMINISTRATION OF $^{65}ZnCl_2$. Avrunina, G. A. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 35-9(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 35-9(1965).

On administration to rats of radioactive zinc with the drinking water with an amount of stable carrier of not more than 0.04 mg/day per rat, no dependence was observed between the level of accumulation of the radioisotope and the intake of stable zinc. On administration of the radioisotope with stable carrier in an amount of 0.4 to 2.0 mg/day per rat a significant inverse ratio was observed between the level of accumulation and the intake of stable isotope. The specific activities of individual organs and tissues were governed by the same relationship as the level of total activity in the body. The activity of the gastrointestinal contents does not depend on intake of stable zinc by the body. The mean radiation doses absorbed by the rat body throughout the period of the experiment were 3.8, 3.6, 3.15, and 1.65 rad for intake of stable zinc of 0, 0.04, 0.4, and 2.0 mg/day per rat, respectively. (auth)

21574 URANIUM CONTENT IN VARIOUS TYPES OF PLANTS IN THE SUBTROPICAL LENKORAN REGION OF AZERBAIDZHAN SSR. Baeva, A. I.; Akhundova, A. B. (Inst. of Soil Studies and Agrochemistry, Baku). Dokl. Akad. Nauk Azerb. SSR; 26: No. 5, 69-71(1970). (In Russian).

Natural radioactivity produced by cosmic radiation from rocks and plants was studied in the subtropical zone in a dry-field region of Nakhichevan, Azerbaidzhan SSR. It was observed that all higher plants examined exhibited a higher β radioactivity than α. Results of 120 analyses of various plants for uranium content in various organs showed a variation of 7.3×10^{-6} to 8.5×10^{-5}%. In ashed oaks (Quercus sp) the U content varied from 8.8×10^{-6} to 2.5×10^{-5}%. Moreover, the content of U in leaves was lower than in branches. In bilberry (Vaccinium sp) and dewberry (Rubus sp) bushes, the content of U varied from 2.8×10^{-5} to 2.0×10^{-3}%. The content of U in ashed samples depended mostly on the location or type of plant. (R.V.J.)

21575 ACCUMULATION OF ^{90}Sr IN HUMAN TEETH AS A RESULT OF NUCLEAR FALL-OUT. Starkey, Will. J. Roy. Nav. Med. Serv. (London); 56: 170-5(Spring 1970).

Strontium-90, resulting from nuclear fallout, is taken up by bone and teeth during periods of calcification. The results are reported of a dental survey carried out by the Royal Navy since 1959. There is a time lag of three to four years between the development of the roots and the development of the crowns in relation to the total period of calcification that allows the probable rate of uptake to be determined from tooth assays. Since there is close correlation between tooth and bone levels, tooth assays may be used to monitor bone levels in living subjects. (auth)

21576 ACCUMULATION AND DISTRIBUTION OF WATER-SOLUBLE RADIOISOTOPES IN FISH EGGS DURING EMBRYOGENESIS. Shekhanova, I. A. Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 69: No. 2, 19-27(1970). (In Russian).

The uptake and distribution of ^{89}Sr, ^{90}Sr, ^{90}Y, ^{32}P, ^{45}Ca, and ^{14}C in the eggs of the rainbow trout (Salmo irridens) and Neogobius melanostomus during embryonic development were studied under various conditions. It was found that the eggs accumulate the dissolved elements during embryogenesis. The intensity of the uptake varies with the stage of development which indicates that it is a physiological process and is based on the needs of the substances for developing organs and tissues. Radioisotopes taken up by the embryo are concentrated in the yellow body which enters into the development of the embryo. This results in an internal source of radiation in addition to the external radiation. (R.V.J.)

21577 ABSORPTION OF IODOVANCOMYCIN BY MICROCOCCUS LYSODEIKTICUS CELLS. Oo, K. C. (National Inst. for Medical Research, London). Aust. J. Exp. Biol. Med. Sci.; 48: 397-405(Aug 1970).

Iodinated vancomycin, when incubated at growth-inhibitory concentrations with a culture of Micrococcus lysodeikticus, was absorbed by the growing cells. Standard methods for estimating vancomycin were not sensitive enough to study the fate of the antibiotic, but the recent synthesis of [^{125}I]-iodovancomycin made this possible. Most of the absorbed radioactive iodovancomycin was located in the cell wall and cell membrane fractions. (Australia)

21578 REMOVAL OF ^{228}Th AND PRODUCTS OF ITS DISSOCIATION FROM THE LUNGS. Makeeva, L. G.; Pavlovskaya, N. A. (Inst. of Labor Protection and Occupational Disease, Moscow). Gig. Sanit.; No. 11, 42-5(Nov 1970). (In Russian).

The content in the lungs of rats of thorium-228 and its decay products after intratracheal introduction was studied. It was found that the chemical state of the compound had a considerable effect on the extent of thorium isotope retention in the lungs. (auth)

21579 TRANSFER COEFFICIENTS OF STRONTIUM AND CESIUM FROM GRASS TO MILK IN DAIRY CATTLE AFTER A SINGLE CONTAMINATION OF PASTURE. van den Hoek, J. (Univ. Wageningen, Netherlands); Kirchmann, R. J. Zentralbl. Veterinarmed., Beih.; No. 11, 95-100(1970).

Normal pasture was contaminated once with a solution containing Sr-85 and Cs-134. The cut grass was weighed and fed to 4 experimental animals. Grass and milk activity were measured. The experiment was repeated four times during the grazing period from May to October. The transfer coefficient from grass to milk for each cow was determined daily for periods ranging from 6 to 12 days. The average percentage of daily ingested Cs-134 secreted per litre of milk varies from 0.31 to 0.45%, whereas the rate was 0.05 to 0.07% for Sr-85. The figures suggest a seasonal change in the transfer coefficient in that more cesium and less strontium is secreted towards the end of the grazing season. When the actually observed milk values are corrected for differences in transfer coefficient, a seasonal increase in milk levels becomes apparent for both nuclides which is thought to be due to the smaller grass yield, normally occurring towards the end of the grazing season. The importance of these findings in the light of environmental contamination is discussed. (auth)

21580 TOXICOLOGY OF NATURAL URANIUM: CONTROL OF INTERNAL CONTAMINATION. Lara Saenz, Maria D. Energ. Nucl. (Madrid); 13: 511-25(Nov-Dec 1969). (In Spanish).

The toxicity of uranium on the human organism can be chemical or radiological according to the way in which it penetrated the organism, the physico-chemical characteristics of the contaminating compound, and the isotopic composition of the uranium. In general the soluble compounds pass rapidly to the blood and are eliminated in the urine; part can be retained, deposited in the kidneys or the bone. In the case of insoluble compounds, the inhaled particles retained in the lungs can irradiate the tissues with subsequent radiation injury. After a review of the physical and chemical characteristics of natural uranium, the various ways of penetration are analyzed: inhalation, ingestion, and absorption across skin and ocular conjunctivitis. In the case of inhalation, the factors which affect the deposition and distribution of the particles in the respi-

ratory tract, such as the dynamics of the mobilization and elimination constants from other organs of the body, are studied. Special mention is made of the mechanism of the toxicity for the kidneys. (tr-auth)

21581 ACCUMULATION OF ^{137}Cs IN POPULATIONS OF TERRESTRIAL VERTEBRATES. Il'enko, A. I.; Fedorov, E. A. Zool. Zh.; 49: 1370-6(1970). (In Russian).

In an artificially contaminated area, the concentration of ^{137}Cs in the body and in the alimentary canal was determined in small rodents, insectivorous animals, large mammals, and birds. Peculiarities of ^{137}Cs migration in different food chains and its qualitative distribution in populations of different animal species were established. In the food chain: plant → small rodents → predators-myophages the following relationships were obtained: $a > b < c$; $a \leq b$ (where a, b, c represent the 1st, 2nd, and 3rd trophic levels). In the food chain: plant → terrestrial invertebrates → mammals, $a < b > c$; $a < b$. In the food chains with insectivorous birds, $a > b > c$; $a > b$. The concentration of ^{137}Cs in small animals was higher than in large ones and lower in adult animals than in young ones. Pregnant and lactating females accumulated this isotope more intensely. Changes were noted in ^{137}Cs availability for plant-eating mammals with the age of radioactive contamination of the biocoenosis. (auth)

21582 ELECTROGALVANIC CURRENTS IN THE ORAL CAVITY AND PATHOLOGICAL CHANGES IN REMOTE ORGANS IN DOGS. Wojciak, Leslaw. Czas. Stomatol.; 23: 1057-61 (Sep 1970). (In Polish).

By using radioactive electrodes with ^{65}Zn and ^{110}Ag fixed within the oral cavity of dogs, it was demonstrated that the ions released in the electrochemical process penetrate into the organism with saliva and are excreted mainly with feces. The scintigraphic examinations of internal organs showed that the concentration of radioactive ions was greatest in the stomach, liver, and spleen and smaller in the heart and kidneys. It was also found that the presence of galvanic piles in the oral cavity of dogs was not without effect on their general health and that these effects depended on the intensity of electrochemical processes determined by the type of pile used. (auth)

Radiation Effects

Refer also to abstracts 20998, 21745, 21747, 21805–21807, 21870, and 21978.

21583 (TID-24270, pp I,21-33) FOREST CHLOROPHYLL AND RADIATION. Odum, Howard T.; Cintron, Gilberto (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

After γ irradiation in El Verde forest leaves growing in a 15-m radius formed little chlorophyll and fell soon after formation. In the 15- to 25-m zone, chlorophyll A increased temporarily before declining to subnormal values that accompanied falling. The overall chlorophyll content of the forest near the Radiation Center before irradiation was estimated at 2.1 g/m^2 of ground area. After dropping to 0.5 or less, the chlorophyll after a year of regeneration and succession increased to 0.92 in the North Cut Center and to 0.66 in the Radiation Center. Unlike some plankton populations the ratio of optical density of pigment extracts at 430 mμ to that at 665 mμ (about 2.0) did not increase much with forest succession. Greater differences were found within one tree than between species of the same general class. The similarity of chlorophyll patterns among different species provides means for a general green forest cover of similar quality for the system reception of incoming energy, even when there is great biochemical diversity as indicated by color shades in an aerial Ektachrome colorphoto (23 color shades per 1000 crowns counted). (P.B.M.)

21584 TISSUE BROWNING OF POTATO TUBERS INDUCED BY GAMMA IRRADIATION. Ogawa, Masami; Uritani, Ikuzo (Nagoya Univ., Japan). Agr. Biol. Chem. (Tokyo): 34: 870-7 (Jun 1970).

A considerable browning was observed especially in cortex tissue and along xylem of potato tubers harvested at Sakai in Osaka Prefecture after irradiation with 10, 20, and 50 krad doses of cobalt-60 gamma rays. This phenomenon was accompanied by a marked increase in polyphenol content and peroxidase activity, and a transient increase in o-diphenol oxidase activity. Total reducing compounds in the tissue were also increased by gamma irradiation. The browning phenomenon depended on the period between harvest and gamma irradiation. The browning and the transient increase in o-diphenol oxidase activity were completely suppressed in the case of tubers irradiated 3 months after harvest. There was no significant change in α-amylase activity in all tubers tested. (auth) (Japan)

21585 METHOD OF ANALYSIS OF RADIATION RESPONSE BASED ON ENZYME KINETICS. Calkins, John (Univ. of Kentucky, Lexington). Radiat. Res.; 45: 50-62(Jan 1971).

A synthesis of modern concepts of repair of radiation damage with a well-known approach to enzyme kinetics is proposed. The resulting formulation provides an accurate prediction of the shape of critical dose-response curves and is in accord with the contemporary molecular biology of radiation action and its repair. The proposed model is more complex than the analogous formulation termed multitarget theory. It is, however, a necessary first step in the process of reconciling the intricate patterns of experimentally observed radiation response with theoretical models. (auth)

21586 TRACK STRUCTURE IN RELATION TO RADIOBIOLOGY. Neary, G. J. (Medical Research Council Radiobiology Unit, Harwell, Eng.). pp 120-6 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Track structure is important in radiobiology because the highly localized pattern of energy deposition on both the cellular and molecular scales influences the nature of the molecular damage in critical cellular elements and the potential consequences for a cell of the production of correlated sites of damage. It is necessary to consider the spectrum of the various precise chemical changes that may result from any one individual energy absorption process (an activation event), the degree of localization of such events, and their possible interactions at the molecular and cellular levels of organization. A number of questions, physical, chemical, biochemical, and biological, on which information is needed are listed. (auth) (UK)

21587 STOCHASTIC EQUATIONS RELATING RBE TO LET. Burch, P. R. J. (Medical Research Council Environmental Radiation Unit, Leeds, Eng. Univ. of Leeds, Eng. General Infirmary, Leeds, Eng.). pp 127-39 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Stochastic equations are developed from the following basic hypothesis: A single ionizing particle may induce biological change through a "hit"—direct or indirect—on a single target structure, or by independent "hits" on each of multiple target structures. Experimental data from the literature for several systems (bacterial inactivation, mutations in yeast, chromatid aberrations, inhibition of clone formation by cells of human origin) are interpreted in terms of the basic hypothesis. The problems of distinguishing between "complex"- and "featureless"-target models are discussed. It is concluded that, in the analysis of the relative biological effectiveness of an irradiation, the detailed internal structure of biological target molecules is as important as the track structure of the ionizing particles. (auth) (UK)

21588 EFFECT OF TRACK STRUCTURE ON OER AT HIGH LET. Curtis, S. B. (Univ. of California, Berkeley). pp 140-2 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

It is suggested that the difference in measured Oxygen Enhancement Ratio (OER) of human kidney cells in vitro obtained with alpha-particle beams and with high energy heavy-ion beams at the same high LET is due to the different energy density distribution in the tracks of the particles involved. In particular, the data from both experiments appear consistent when plotted against the parameter Z^{*2}/β^2, where Z^* is the effective charge on the incoming ion and β is its velocity relative to that of light. This parameter is a measure of the energy density from "close-collision" delta rays at a point near, but not necessarily in, the track core. (auth) (UK)

21589 NONIONIZING INTERACTIONS. Jung, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 190-6 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Experimental studies in dry systems show some nonionizing interactions such as elastic nuclear collisions and attack by thermal

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hydrogen atoms to cause biological damage similar to, though naturally differing in quantity and/or quality, from the damage caused by excitations and ionizations. Elastic collisions were investigated using low-energy protons. Hydrogen atoms were generated in a gas discharge or, alternatively, by irradiating plastic foils with 2-MeV protons. In either case, exponential inactivation curves were obtained with infectious DNA extracted from bacteriophage ΦX174 and with chromatographically purified ribonuclease. The results indicate that, because of processes of diffusion, the local distribution of damaged molecules is necessarily different, to some extent, from the local distribution of excitations and ionizations, i.e., different from the original structure of the track of a charged particle. (auth) (UK)

21590 EFFECTS OF IONIZING RADIATIONS ON MYELIN FORMATION IN RAT BRAIN CULTURES. Mamoon, Abdel-Megid. Berkeley, Calif.; Univ. of California (1970). 178p. University Microfilms Order No. 71-811.

Thesis.

Organotypic cultures from newborn rat brains at different postnatal ages were maintained in an apparently healthy condition for at least two months. Explants (about 1 mm^3 in volume and 1 mm thick) from cerebella and midbrains were used. The explants were embedded in a plasma clot and incubated in roller tubes. An incubation temperature of 36°C and glucose concentration of 6.5 mg/ml. of the feeding medium resulted in the highest percentage of all incubated explants becoming myelinated. Blood vessels and any preexisting myelin degenerated upon explantation. At 15 days postincubation over 90% of the incubated explants had developed abundant and apparently normal myelination. The effects of ionizing radiations on myelin formation in the cultures were studied using 145 Kvp x-rays, 36 MeV helium ions, 54 MeV helium ions and 30 MeV deuterium ions. Freshly dissected explants were exposed to radiations and the number of myelinated explants at 15 days in vitro compared to the total number irradiated was used as an index for myelination damage. The modification of such damage by radiation dose and age of animal used was investigated. The results showed, that although the radiations used differed in their LET and dose rates, they were not significantly different in their effectiveness. The mean radiation dose that resulted in only 50% of the explants (compared to the controls) becoming myelinated was 1727 ± 115 rads (mean ± 1SD). A dose above 400 rads was needed in order to produce observable effect on myelination and the damage increased with the dose. At 4000 rads all exposed explants did not develop myelin. No recovery of myelination was observed in amyelinated cultures during an observation period of one month. Explants from 8 day old animals were found to be significantly more radio-resistant to myelination damage when compared to those from 1 day old animals. Many nerve cells (>20 μ) in most cultures even after exposure to 4000 rads were apparently unaffected, irrespective of age of animal used, when examined at 15 days postirradiation. The axons were similarly unaffected. In contrast, small cells (5–15 μ) which include small nerve cells and glia were markedly reduced in density by 4000 rads. It is concluded that damage to myelination in vitro is due to direct glial cell damage. The chance for affecting more of these cells increases with the dose. Since these cells occur in greater density in explants from 8 day old animals than in those from 1 day old animals (myelination gliosis), a higher dose will be needed to damage enough glial cells in the former explants in order to produce myelination damage. Although radiation damage to blood vessels in vivo may initiate or contribute to myelination damage, the present findings show that glial injury, in absence of blood vessels leads to myelination damage, at doses comparable to those used in vivo. (Diss. Abstr. Int., B)

21591 EFFECTS OF X IRRADIATION ON THE NUCLEOHISTONES OF MURINE S-180 ASCITES TUMOR CELLS. Schenken, Larry Lane. Iowa City, Ia.; Univ. of Iowa (1970). 101p. University Microfilms Order No. 70-15,641.

Thesis.

The effects of x-irradiation on S-180 ascites tumor cell histones were investigated. Changes in nucleohistones were measured by uv absorption spectroscopy and polyacrylamide gel electrophoretic techniques. Histones were irradiated in vitro following acid extraction from unirradiated tumor cells in logarithmic growth phase. Histones were also extracted and analyzed at various times following in vivo irradiation of the tumor cells. The results of in vitro studies indicated extreme sensitivity of aromatic amino acid moieties within the histone. Immediately following irradiation, the aromatic amino acids lost the ability to respond to uv light as active chromophores. However, this component of radioinduced damage was reversible under acidic storage conditions, and hypochromic shifts noted at 276 nm were shortly restored to control levels. Generalized radioinduced hyperchromic shifts in absorption at shorter wavelengths increased in a time-dependent fashion during the first 12 hours following irradiation. Densitometric tracings of polyacrylamide gel patterns of irradiated nucleohistones suggested no differential radiosensistivity of the major electrophoretic groups, but did show an increase in disulfide crosslinkages of the second major electrophoretic group of histones. Such tracings also revealed a post-irradiation increase in nondescript radiolysis products as evidenced by additional fine banding not seen in gels of unirradiated histones. In vitro effects appeared to be caused primarily by the indirect action of radiation, i.e., by the formation of damaging species of free radicals within the medium. Chemical protection studies with mercaptoethylamine added prior to irradiation showed significant decreases in radiation damage. Dilution studies indicated that the absolute amount of damage as assayed by difference absorption spectroscopy was independent of the concentration of the histone irradiated, but the per cent of damaged histone increased with increasing dilution. Addition of oxygen enhanced radioinduced changes. Anoxic conditions during irradiation protected the histone to a great extent. In vivo studies with exposures of 0 to 600 R showed none of the above-mentioned effects. High (8 kR to 10 kR) exposures, however, did result in increased disulfide bridging and a generalized increase in radiolysis products. A transient increase in the relative amount of histone extracted along with DNA in deoxynucleoprotein of tumor cells closely paralleled the time sequence of radioinduced cleavage delay in the tumor cells. The effects of added histones on kinetics of tumor cells were investigated. Levels as low as 1 mg/4.2×10^9 cells, when injected IP into mice, caused a G_2 cleavage delay very similar in appearance to radioinduced cleavage delay. A second, dose dependent, component of damage to cells in S phase during exposure to the histone was noted. The injection of isotonic saline or osmotically equivalent quantities of a foreign protein such as bovine serum albumin had no effects on cell kinetics. However, the addition of polycationic protein such as cytochrome-C caused responses similar to those observed following the addition of histones. These observations are not inconsistent with the proposal that radioinduced changes in nucleohistone quantity or biochemical state are closely related to onset and duration of radioinduced cleavage delay. (Diss. Abstr. Int., B)

21592 FREE AMINO ACIDS DURING GERMINATION OF γ-IRRADIATED GROUNDNUT. Patel, G. M.; Patel, K. C.; Patel, R. D. (Sardar Patel Univ., Vallabh Vidyanagar, India). J. Agr. Food Chem.; 18: 1168-71(Nov–Dec 1970).

The method of circular paper chromatography allowed estimation of 19 amino acids during germination of control and γ-irradiated groundnuts. The seeds were exposed to 10, 30, 50, 70, 90, and 120 kR dosage levels. Some amino acids, which are absent in the ungerminated seeds, were detected during the course of germination periods of 1, 3, 6, 12, 20, and 30 days. Biosynthesis of the free amino acid was affected by γ-irradiation. Carbohydrate and photosynthesis had specific effects on the production of some of the amino acids. (auth)

21593 TRANSFER OF RADIATION ENERGY BETWEEN MACROMOLECULES AT 77°K. Copeland, E. S.; Sammer, T.; Pihl, A. (Norwegian Radium Hospital, Oslo). Int. J. Radiat. Biol.; 18: 85-9(1970).

ESR studies were carried out on freeze dried mixtures of trypsin and various types of the cross-linked dextran Sephadex. Irradiation was with x rays (220 kV, 20 mA) at a dose of 4.8×10^5 R, and a dose rate of 4.6 kR/min, and spectra were observed at 77°K. Evidence of energy transfer was obtained for mixtures of 60% Sephadex G-200 and 40% trypsin, but not for 20% G-200 and 80% trypsin, or in experiments with Sephadex G-25, where all the trypsin was localized on the surface of the Sephadex particles. The results could be explained by the calculation that per gram of Sephadex G-200, a maximum of 0.1 gram of trypsin was embedded in the dextran matrix in a way in which it could take part in a transfer reaction, so that in the 20% G-200, 80% trypsin mixture, only 2.5% of the trypsin present could take part in the reaction, and this was below the resolution of the method. (UK)

21594 THE PROTECTION OF DNA AGAINST IONIZING RADIATION BY ACTINOMYCIN D IN VITRO. Kollmann, George; Martin, David; Shapiro, Bernard (Albert Einstein Medical Center, Philadelphia). Int. J. Radiat. Biol.; 16: 121-8(1969).

Highly-polymerized salmon-sperm DNA was irradiated in solution with and without Actinomycin D, Actinamine and the radiation-protective agent bis(2-guanidoethyl)disulphide (GED). The specific viscosity of these solutions was determined as a measure of DNA damage. Without the added agents, 25 kR (^{60}Co γ-rays) reduced specific viscosity measured at 30° to less than 20 percent of the unirradiated DNA solutions. Actinomycin D and GED preserved

XUN

over 90 percent of the specific viscosity. When viscosity was measured at 90°, where DNA exists as single strands, 25 kR reduced specific viscosity to less than 10 percent, GED showed some protection, and Actinomycin D still preserved 90 percent of the viscosity. Actinamine was non-protective. Binding of the agents to DNA was measured by equilibrium dialysis and showed the following order: Actinamine > Actinomycin D > GED. The results indicated that protection of DNA in this system depends on (1) the structure of the protective agent, (2) the amount of agent bound to DNA, and (3) the nature of the binding of the agent to DNA. (auth) (UK)

21595 SERUM PROTEINS IN RATS IRRADIATED DURING PRENATAL DEVELOPMENT. Rudnicki, Tadeusz; Wronski, Anastazy. Acta Physiol. Pol.; 21: 785-92(Nov-Dec 1970). (In Polish).

Changes in serum protein fractions during physiological aging in rats exposed to ionizing radiation during prenatal development were studied. The influence of whole body irradiation or long term starvation on serum protein spectrum was also investigated. Irradiation during fetal development reduces the aging of proteins and changes their reactions to the additional physiopathological factors. (auth)

21596 INVESTIGATIONS ON THE THRESHOLD DOSES FOR SOME IRRADIATION REACTIONS IN HUMAN LYMPHOCYTES IN VITRO. Rudnicki, Tadeusz; Sloninska, Barbara. Acta Physiol. Pol.; 21: 793-800(Nov-Dec 1970). (In Polish).

Investigations were carried out to ascertain the approximate values of the terms small dose and threshold dose. Human lymphocyte cells were used in the experiment and irradiated in vitro. (P.B.M.)

21597 UNSCHEDULED DNA SYNTHESIS AND REPAIR OF HeLa S-63 CELLS SUBLETHALLY DAMAGED BY IRRADIATION. Paribok, V. P.; Semenova, E. G. (Inst. of Cytology, Leningrad). Tsitologiya; 12: 1423-32(Nov 1970). (In Russian).

The dose survival curve of HeLa S-63 cells exposed to ultraviolet light (2537 Å) is exponential and no effect of the fractionation is observed. The unscheduled DNA synthesis is detected for all the cells in G_1 and G_2 after uv-irradiation. The dose survival curve of HeLa cells after x-irradiation in G_1-phase is S-shaped; the effect of the fractionation is present. Thus, the repair of cells sublethally damaged by x-irradiation does take place. The unscheduled DNA synthesis was not shown for cells that underwent x-irradiation in G_1-phase. These results suggest that the repair of sublethally damaged HeLa cells may occur without the unscheduled DNA synthesis detected by autoradiography. The sensitivity of the method comprises 0.47% of the whole cell DNA. The unscheduled DNA synthesis after uv-irradiation of HeLa S-63 cells is highly radioresistant; it is not depressed by x-irradiation (100,000 rads). (auth)

21598 LDH ACTIVITY AND ISOENZYME PATTERN IN SERUM OF FEMALE WISTAR RATS AND THEIR OFFSPRING: COMPARISON BETWEEN SHAM-IRRADIATED ANIMALS AND THOSE RECEIVING 400 R WHOLE-BODY X-RAY DOSE. Goetze, T.; Saubert, P.; Goetze, E. (Friedrich-Schiller Univ., Jena, Ger.). Acta Biol. Med. Ger.; 25: 519-22(1970). (In German).

Wistar rats were exposed to 400 R of whole-body x radiation on the seventeenth day of gestation. Four hours after birth on the 22nd day of gestation, the LDH activity in the serum of the mothers was reduced to ⅓ that of control animals. The offspring of irradiated mothers showed an increase in serum LDH activity by more than twice the normal values. (tr-auth)

Immunology

Refer also to abstracts 21720, 21737, 21879, 21881, 21882, 21901, and 21983.

21599 RESISTANCE TO EIMERIA INFECTIONS IN THE CHICKEN. THE EFFECTS OF THYMECTOMY, BURSECTOMY, WHOLE BODY IRRADIATION, AND CORTISONE TREATMENT. Rose, M. Elaine; Long, P. L. (Houghton Poultry Research Station, Huntingdon, Eng.). Parasitology; 60: 291-9(Apr 1970).

Surgical bursectomy or thymectomy at day old had little effect on primary or subsequent infections with E. brunetti or E. maxima. Whole body irradiation of day-old chickens with 700 or 750 R did not affect the development of immunity to these Eimeria spp., but in some experiments it affected oocyst production during initial infections. In one of four trials, birds surgically bursectomized and irradiated produced twice as many E. brunetti oocysts during an initial infection as the irradiated only controls; in the remaining three trials, oocyst production in the operated birds was either similar to or slightly greater than that in the controls. Combined bursectomy and irradiation did not affect immunity to re-infection. Combined thymectomy and irradiation had little effect on primary infections (increased oocyst output was found in only one of six trials) and no effect on subsequent immunity; mean body weights and circulating lymphocyte numbers were decreased but tuberculin sensitivity was reduced in only a small proportion of the birds, indicating that the cell mediated immune responses of the majority were not affected. Small (0.75 mg) daily doses of cortisone acetate given to irradiated birds or irradiated thymectomized birds, did not affect resistance to reinfection with E. brunetti. (auth)

21600 ENHANCEMENT OF RESIDUAL ANTIBODY SYNTHESIS BY IRRADIATION OF THE SPLEEN IN PRE-IMMUNIZED RATS. Simic, Miroslav M. (Inst. for Biological Research, Belgrade); Petrovic, Milica Z. Nature (London); 229: 263-4(22 Jan 1971).

The effects of localized heavy irradiation (1,000 or 10,000 R of x rays) of the exposed spleen (with body shielding) on antibody synthesis were studied in rats irradiated several weeks after a priming injection of sheep red blood cells used as antigen. It was concluded that the spleen is the main site of production of both the residual pre- and post-radiation titres and that the recovery of residual titres depended upon the response of cells other than in the spleen. The cellular basis of the described phenomenon was studied, from which it was concluded that recovery and overshoot of residual titres represents a small secondary response which occurs without additional injected antigen. The heavy irradiation did not totally suppress the capacity of the spleen for residual antibody synthesis. In fact, not only did residual titres recover within a few days, but there was a marked overshoot. The mechanism to account for this is discussed. (UK)

21601 STIMULATION OF AUTOCHTHONOUS LYMPHOCYTES BY CELLS FROM NORMAL AND LEUKAEMIC LINES. Knight, Stella, C. (New York Univ., N. Y.); Moore, George E.; Clarkson, Bayard D. Nature (London) New Biol.; 229: 185-7(10 Feb 1971).

A reaction similar to the normal mixed lymphocyte reaction (MLR) but of greater magnitude occurs when irradiated lymphoid cells from lymphoblastoid cell lines (LCL) are added to freshly isolated peripheral lymphocytes from allogeneic individuals. The intense stimulation which occurred in every case when irradiated cells from various LCL were added to lymphocytes from a large number of individuals (Knight et al 1970) suggested the presence of extra surface determinants on the cells, which are not present on normal freshly isolated cells. This communication reports the investigation on whether freshly isolated lymphoid cells could detect and respond to extra antigenic determinants on the surface of cell lines derived more than three months earlier from their own lymphoid cells. The stimulation of lymphocytes by x irradiated cells from lymphoid cell lines is tabulated, from which it is seen that both antochthonous and allogeneic LCL cells stimulated freshly isolated lymphocytes. Irradiated autologous LCL cells derived from both normal and leukaemic individuals stimulated freshly isolated autochthonous cells. (UK)

21602 PREVENTION AND TREATMENT OF THE GRAFT VERSUS HOST REACTION IN RADIATION CHIMERAS BY ANTI-LYMPHOCYTE SERUM. Suvatte, Vinai. Boulder, Colo.; Univ. of Colorado (1969). 85p. University Microfilms Order No. 70-16,525.

Thesis.

The serious mortality and morbidity of the graft versus host reaction (GVHR) is still a deterrent to the clinical use of bone marrow transplantation. Antilymphocyte serum (ALS) was investigated for its ability to modify the GVHR following allogeneic bone marrow transplantation in lethally irradiated adult BALB/C mice. Antilymphocyte serum was prepared by giving three intraperitoneal injections of 300×10^6 washed lymphocytes from adult C57BL mouse lymph nodes and thymus into rabbits at weekly intervals. The antiserum was inactivated and absorbed with washed mouse red cells until free from hemolysins and agglutinins. The effectiveness of rabbit antimouse lymphocyte serum was tested in vitro by trypan blue cytotoxic test, and in vivo by production of persistent lymphopenia. Six groups of 22 week old female BALB/C mice, 20 in each group, were exposed to 1000 R γ (LD_{100}) from a ^{60}Co source. All mice received 20×10^6 bone marrow cells from adult female C57BL mice intravensouly within six hours after x irradiation. One group was left as irradiated, transplanted controls and received no further treatment. In this transplanted control group (no ALS), death occurred from GVHR between 25 and 55 days after bone marrow transplantation, and the cumulative mortality was 70%. Another four groups were treated with ALS at various times after bone marrow transplantation. When ALS therapy was started on day one after bone marrow transplantation, the majority of mice died within 10 to 20 days and the cumulative mortality was

85%. This indicates that early treatment may destroy the bone marrow graft. When treatment with ALS was begun either on day five or day 10 after transplantation and continued for short periods of time, death from GVHR was delayed but the mortality was decreased only to 50%. Prolonged treatment of the host with ALS resulted in marked lymphoid atrophy and increased susceptibility to infections in radiation chimeras. However, when C57BL donors were pretreated in vivo with ALS for five days, death from GVHR in the x-irradiated BALB/C recipients was markedly decreased to 15%. The presence of donor bone marrow cells could be detected in the surviving radiation chimeras in the latter group by demonstrating donor type hemoglobin. Both humoral and cellular immunocompetence were found to be present in these radiation chimeras though skin graft rejection was slightly delayed and antibody production was reduced. These studies indicate that ALS can modify the GVHR following allogeneic bone marrow transplantation more effectively if used to treat the donor rather than the host. The results of this investigation support the hypothesis that ALS acts primarily upon immunocompetent lymphocytes while they are in the circulation, leaving the hemopoietic stem cells in the bone marrow relatively undisturbed if the ALS is used to treat the potential donors in vivo before transplantation. (Diss. Abstr. Int., B)

21603 EFFECT OF IONIZING RADIATIONS ON THE HUMORAL IMMUNITY. EFFECT OF CUMULATIVE DOSES OF X RADIATION ON THE SERUM ANTIBODIES AND THE CIRCULATING LEUKOCYTES IN MICE WITH PRE-IMMUNIZATION. Petrescu, D.; Boros, I.; Papahagi-Dumitrescu, Elena; Corneci, I. Stud. Cercet. Fiziol.; 15: 153-62(1970). (In Rumanian).

The whole-body irradiation of mice by x rays using fractionation of total doses (150 to 450 R) showed that the fractionated administration of the radiations caused the same reactions induced by the same doses in single application on the homeostasis of the circulating leukocytes and the capacity for the formation of antibodies. The reestablishment of homeostatic equilibrium disturbed by high doses (150 to 450 R) in single application was completed after an interval, which is about 30 days for the mouse. (52 references.) (tr-auth)

21604 PROLONGATION OF ALLOGRAFT SURVIVAL BY DONOR IRRADIATION. Kyger, E. Ross; Salyer, Kenneth E.; Ecker, Roger R.; Webb, Watts R. (Univ. of Texas, Dallas. Univ. of Pennsylvania, Philadelphia). Surg. Forum; 21: 288-9 (1970).

From 26th Annual Sessions of the Forum on Fundamental Surgical Problems, 56th Clinical Congress of the American College of Surgeons, Chicago, Ill. See CONF-701014.

Experiments were undertaken to attempt to improve allograft survival by suppressing the immune system to the donor rather than the recipient. Female Lewis donor rats received 800 R of whole-body ^{60}Co γ radiation. Skin grafts were then removed at one and two week intervals from the donor rats and placed on the lateral thoracic area of male buffalo rats. The use of donors treated with radiation 14 days prior to graft removal resulted in a mean graft survival of 31 days in contrast to 9.4 days using donors irradiated only seven days before graft removal. The results indicated that the donor immune system plays a crucial role in allograft rejection. (E.E.H.)

21605 IMMUNE RESPONSES AND LYMPHOID TISSUES OF NEONATALLY THYMECTOMIZED, X-IRRADIATED MICE. Mosser, G.; Good, R. A.; Cooper, M. D. (Univ. of Minnesota, Minneapolis). Int. Arch. Allergy Appl. Immunol.; 39: No. 1, 62-81(1970).

Swiss–Webster albino mice were thymectomized and x-irradiated at birth. Their antibody responses to Brucella abortus were slightly depressed; their responses to Salmonella typhosa H antigen were normal; and their responses to SRBC were greatly depressed. Their immunoglobulins were normal by immunoelectrophoresis. They could not effect graft-versus-host reactions and had very few small lymphocytes in the blood and in the thymus-dependent areas of the spleen and lymph nodes. Morphological examination of their lymph nodes revealed a striking uniformity among the remaining lymphocytes. Two distinct populations of lymphocytes in normal peripheral lymph nodes were then identified by light microscopy. The inconstant antibody responses of thymectomized mice may reflect secondary influences at work in mice that are under abnormal stress because they lack the thymus-dependent system. Alternatively, the inconstant responses might indicate that the thymus-dependent system is necessary for normal antibody responses to some antigens but not for responses to others. (auth)

21606 EFFECT OF PROLONGED ADMINISTRATION OF RADIOZINC (^{65}Zn) ON THE ANTIGENIC STRUCTURE OF RABBIT TISSUES. Filatov, P. P. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 124-37(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 124-37(1965).

Prolonged administration of ^{65}Zn in an amount of 10 and 1 μCi/kg produces a distinct change in the antigenic structure of certain tissues. The degree of change in the antigenic structure varies in different tissues due apparently to the different quantities of lymphoid elements and microbial antigens. Following prolonged administration of 0.1 μCi/kg ^{65}Zn (19 months) some change in the antigenic properties of liver tissue was noted. (auth)

21607 EFFECT OF CHRONIC EXPOSURE TO RADIOACTIVE ZINC (^{65}Zn) ON ANTIBODY FORMATION. Filatov, P. P. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 138-48 (1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 138-48(1965).

Prolonged burdening of animals with radioactive zinc in doses of 10 and 1 μCi/kg reduces the ability of the body to form antibodies to administered antigens. An appreciable difference in the titres of complement-fixing antibodies on prolonged administration of radiozinc in a dose of 0.1 μCi/kg in the test and control animals was not noted but comparative study of accumulation of antibodies by the CFT and ring precipitation tests revealed change in the avidity of the antibodies for antigen in the test animals. (auth)

21608 CELLULAR AUTOIMMUNE REACTIONS FOLLOWING RADIOIODINE TREATMENT FOR HYPERTHYROIDISM. Einhorn, Nina; Wasserman, J.; Packalen, T. (Radiumhemmet, Stockholm). Acta Radiol., Ther., Phys., Biol.; 9: 225-32(Jun 1970).

Material from 25 subjects, including eight patients who had previously received radioiodine therapy, was examined to determine whether cellular reactivity to thyroid antigens developed. The preliminary results are discussed in detail. (auth) (Sweden)

21609 TRANSFER OF IMMUNOLOGICAL COMPETENCE TO RATS TOLERANT OF SHEEP ERYTHROCYTES WITH LYMPHOCYTES FROM NORMAL RATS. McCullagh, R. J. (Australian National Univ., Canberra). Aust. J. Exp. Biol. Med. Sci.; 48: 351-67(Aug 1970).

An explanation was sought for the mechanism whereby prior irradiation of rats tolerant of sheep erythrocytes facilitates hemolysin formation by transfused normal lymphocytes. Taking account of the effects of depleting tolerant rats of lymphocytes by means of prolonged thoracic duct drainage, it was concluded that enhanced colonization of host lymphoid tissues by transfused cells was unlikely to be the major factor in this facilitation. The formation of hemolysin was investigated in tolerant rats after sublethal irradiation and the transfer of lymphocytes from normal donors. The hemolysin response after the transfer of thoracic duct lymphocytes to irradiated, tolerant hosts was much weaker than that observed after their transfer to irradiated normal (nontolerant) hosts unless the lymphocytes had been incubated in vitro with antigen-primed peritoneal cells. Previous incubation of the lymphocytes to be injected with unprimed peritoneal cells or with antigen alone failed to enhance the subsequent immune response. Lymphocytes and primed peritoneal cells which had not been incubated together were a much less efficient inoculum than incubated cell mixtures. It is suggested that, in addition to the specific deficiency of its lymphocytes, there is some factor in the tolerant rat inimical to the initiation of an immune response in transfused normal lymphocytes. (auth) (Australia)

21610 STUDIES ON LYMPHOCYTES. XVII. DIFFERENTIAL LYMPHOCYTE DEPLETION IN LYMPHORETICULAR ORGANS OF THE CALF DURING CONTINUOUS EXTRACORPOREAL X-IRRADIATION OF THE CIRCULATING BLOOD. Ruchti, C.; Cottier, H.; Cronkite, E. P.; Jansen, C. R.; Rai, Kanti R. (Univ., Bern. Brookhaven National Lab., Upton, N. Y. Atomic Energy Board, Pretoria). Cell Tissue Kinet.; 3: 301-15(Jul 1970).

Continuous extracorporeal irradiation of the circulating blood (ECIB) of from 3 to 50.5 hr duration was used to study in the calf the differential depletion of lymphocytes from spleen, lymph nodes, and thymus as compared to blood and thoracic duct lymph. The cell content of tissues was measured by planimetry and/or test point analysis. Lymphocyte depletion by ECIB from various lymphoreticular organs, and from different areas within a given organ, was less than in the circulating blood or the thoracic duct lymph and varied from one site of a lymphoreticular organ to another. Elimination of lymphocytes by ECIB from all tissues studied was observed within 10 to 15 hr, indicating that the rate of exchange with blood is similar for this group of cells in various lymphoreticular tissues. (auth)

21611 TRANSFER OF DELAYED AND ARTHUS SENSITIVITY WITH BLOOD PLASMA FROM X-IRRADIATED GUINEA-PIGS. Collins, F. M.; Volkman, A.; McGregor, D. D. (Trudeau Inst., Inc., Saranac Lake, N. Y.). Immunology: 19: 501-9(Sep 1970).

Lethal x irradiation of sensitized guinea-pigs failed to release a mediator of delayed-type hypersensitivity into plasma in sufficient concentration to effect passive transfer of reactivity to tuberculoprotein or hen ovalbumin. But plasma from such animals did sensitize recipients for an Arthus reaction; and some of this early inflammation, both in actively and passively sensitized subjects, was still apparent at 24 hours. The significance of these late reactions is discussed in relation to the problem they pose when attempting to demonstrate a mediator of delayed-type hypersensitivity. (auth) (UK)

21612 EFFECTS OF VACCINATION WITH IRRADIATED PLASMODIUM BERGHEI ON THE ACTIVITY OF PHAGOCYTES IN THE RETICULOENDOTHELIAL SYSTEM AFTER INFECTION OF RATS WITH PLASMODIUM. Biozzi, G. (Centre National de la Recherche Scientifique, Paris); Stiffel, C.; Mouton, D.; Decreusefond, C.; Corradetti, A.; Verolini, F.; Bucci, A.; Ventura, A. Bull. World Health Organ.; 42: 163-8(1970). (In French).

The modifications of the phagocyte activity of the reticuloendothelial system during the infection with P. berghei in the rat infected by blood inoculation were studied. The response of the reticuloendothelial system in rats infected after vaccination with irradiated P. berghei was also studied in order to attempt to clarify the mechanism of the protection obtained under these conditions. In the rats infected with P. berghei the phagocyte activity shows a sharp increase on the 6th day of the infection which corresponds to the beginning of the parasitism. This stimulation then decreases progressively but persists even after the disappearance of the infection in the surviving rats. This response concerns the total activity of the reticuloendothelial cells of the liver and spleen whose masses are increased during the infection. Consequently, the specific phagocyte activity expressed by weight unit of these two organs is only slightly modified. In the rats vaccinated with irradiated P. berghei, the phagocyte activity of the reticuloendothelial system increases progressively up to the 20th day after vaccination, at which time the rats are infected with P. berghei. There is a chronological agreement between the appearance of the resistance produced by the vaccination and the stimulation of the reticuloendothelial system. The vaccination induces a considerable protection which is shown by the survival of all the vaccinated animals, whereas 70 to 80% of the non-vaccinated animals succumbed to the infection. The phagocyte activity already increased by the vaccination reaches the same maximum values as in the non-vaccinated animals. The duration of this stimulation is transitory and the function of the reticuloendothelial system returns rapidly to normal values. (tr-auth)

Ecology

Refer also to abstracts 21540, 21581, 21675, 21676, 21679, 21690, 21691, 21845, 21953, 21973, 23206, and 23220.

21613 (COO-1156-40) RADIOECOLOGY OF SOME NATURAL ORGANISMS AND SYSTEMS IN COLORADO. Ninth Annual Progress Report, January 1-December 31, 1970. Whicker, F. W.; Johnson, J. E.; Fraley, L. Jr. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). 1 Feb 1971. Contract AT-(11-1)-1156. 50p. Dep. NTIS.

Separate abstracts were prepared for the five sections of the report. A list of publications and a list of oral presentations of findings of the research are included. (H.L.W.)

For abstracts of individual sections see: 21614-21618.

21614 (COO-1156-40, pp 4-11) RADIONUCLIDE STUDIES WITH MULE DEER. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology).

In Radioecology of some natural organisms and systems in Colorado.

Effects of seasonal and age variations of strontium and calcium kinetics in mule deer (Oedocoileus hemionus) were investigated. Emphasis was placed on Ca-Sr kinetics in relation to antler development, doe to fetus transfer during gestation, and doe to fawn transfer during lactation. A table is presented to show results following acute oral ingestion of 450 μCi of ^{85}Sr. Tissue samples from 12 wild mule deer killed in Colorado were obtained in 1970. Muscle tissues were assayed for ^{137}Cs, thyroids were analyzed for ^{131}I, and three metacarpal bones were assayed for ^{90}Sr. Results are tabulated. (H.L.W.)

21615 (COO-1156-40, pp 12-16) RADIONUCLIDE STUDIES OF AQUATIC SYSTEMS. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology).

In Radioecology of some natural organisms and systems in Colorado.

A solution of cesium-133-labeled cesium chloride was distributed in East Twin Lake. Sampling was initiated one hour later and included water, sediments, aquatic plants, zooplankton, crustaceans, and fish. Sampling intervals were gradually lengthened from every few hours at the beginning of the experiment to every two weeks. Results are presented for percent survival of the crustaceans, Gammarus and Cyclops, exposed for five days to various ^{133}Cs concentrations. Concentrations of ^{137}Cs and ^{90}Sr were measured in tissues of five trout species taken from 51 mountain lakes in Colorado during 1965 to 1970. Data were collected from each lake in an effort to relate radionuclide levels to ecological factors. A yearly decrease in ^{137}Cs levels was observed with the rate of decrease becoming smaller through the sampling period. The temporal trend was fit by a model employing a fallout rate factor and a cumulative deposition factor. (H.L.W.)

21616 (COO-1156-40, pp 17-30) STUDIES ON THE PIKA. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology).

In Radioecology of some natural organisms and systems in Colorado.

Pikas were released in two one-acre enclosures and irradiated two months later. More irradiated animals died in the 15 cage area than in the individual pens during both experiments. The response in the 31 cage area was not significantly greater than the response in the individual pens. Survival times for irradiation-caused mortalities are tabulated. It was found that pikas that were free to interact in enclosures were more radiosensitive than animals individually confined. The survival times indicated that the more radiosensitive a group of pikas were, the shorter the survival time for radioinduced mortalities. For studies on reproduction two females were given 300 R of γ radiation; one produced a litter of three and the other did not have young. A captive animal from the 1969 experiment that received 500 R γ radiation produced a litter of one. (H.L.W.)

21617 (COO-1156-40, pp 31-6) RADIATION EFFECTS ON A NATIVE SHORTGRASS PLANT STAND. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology).

In Radioecology of some natural organisms and systems in Colorado.

Studies were conducted on the effect of chronic irradiation on the diversity index. Data were plotted and hand-fit with curves to estimate exposure rates which gave a 50% reduction in the diversity index. A figure is presented to show a three-dimensional plot representing combined data on diversity index, time, and exposure rate. It is seen that the diversity index of the shortgrass plant stand was more sensitive to the radiation each spring than during other seasons of the year. (H.L.W.)

21618 (COO-1156-40, pp 37-41) RADIATION RESPONSE AND FOOD WEBS OF GRASSLAND ARTHROPODS. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology).

In Radioecology of some natural organisms and systems in Colorado.

Investigations were conducted on the effects of γ radiation on populations of arthropods and on the plant community. Trapping data were collected and analyzed for relationships between relative population numbers and the primary and secondary effects of ionizing radiation on selected foraging and predaceous arthropods. Observations were made on the rabbitbrush (Chrysothamnus nauseosus) within the irradiation facility enclosure for numbers of galls caused by the fly (Aciurina bigeloviae). Studies on arthropod food chains and consumption rates were conducted using phosphorus-32 as a tracer. The grass, Boutelous gracilis, was labeled with ^{32}P; when samples of the grass and arthropods were counted for ^{32}P activity, it was found that herbivorous arthropods, especially leafhoppers (Cicadellidae) were consumers of Boutelous and that the wolf spider accumulated such high levels of activity that it was implicated as a predator of the leafhoppers. Other studies on labeled Boutelous showed that the grasshoppers, Arphia conspersa and A. pseudonietana, consumed the labeled grass. (H.L.W.)

21619 (ORNL-4634) ECOLOGICAL SCIENCES DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1970. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 141p. Dep. NTIS.

Separate abstracts were prepared for five sections of the report

Three additional sections are included on the biogeochemical ecology, information center, systems ecology, and forest management. Lists of publications, lectures, theses, and professional activities are appended. (H.L.W.)

For abstracts of individual sections see: 21620–21624.

21620 (ORNL–4634, pp 1-20) RESPONSES OF ANIMAL POPULATIONS TO IONIZING RADIATION. (Oak Ridge National Lab., Tenn.).

From Ecological sciences division annual progress report for period ending July 31, 1970.

Investigations were conducted on the effects of chronic γ radiation on the reproduction and survival of populations of snails (Physa heterostropha); some experiments included combined effects of temperature and radiation on laboratory populations. Graphs are presented to show results of studies on natural and laboratory populations. Progress is reported on the effects of tritiated water on chromosomes of the midge (Chironomus riparius); effects of various doses of γ radiation on survival of Acheta domesticus; effects of 1500 and 3000 R γ radiation on colonies of honeybees; embryonic development of carp (Cyprinus carpio) eggs as a biological test; effects of acute β and γ radiation, temperature, tritiated water, and herbicides on carp eggs; daily carbon dioxide production of three species of small rodents; a comparative study of hematological responses in the mongolian gerbil and white-footed mouse after acute γ radiation; radioactivity in cotton rats exposed to ^{137}Cs in contaminated outdoor enclosures; and seasonal response to radiation in white-footed mice. (H.L.W.)

21621 (ORNL–4634, pp 21-52) RADIONUCLIDE CYCLING IN TERRESTRIAL ECOSYSTEMS. (Oak Ridge National Lab., Tenn.).

From Ecological sciences division annual progress report for period ending July 31, 1970.

A preliminary carbon budget is described for a Liriodendron forest and a diagram of a carbon model for an Oak Ridge forest ecosystem is presented. Phenological studies were conducted on vascular plants in relation to biomass increment, mineral composition, and meteorological phenomena. A model was developed for study of leaf, crown, and canopy development of a Liriodendron forest. Progress is reported on trends of foliage and soil data on ^{137}Cs in a tagged Appalachian forest dominated by Liriodendron tulipifera; distribution of ^{137}Cs in soil of the tagged Liriodendron forest; cesium-137 concentrations in litter invertebrates from the tagged Liriodendron forest; seasonal distribution of earthworm numbers, biomass, and ^{137}Cs body burdens in the tagged Liriodendron forest; trophic delineation of soil microarthropods using ^{137}Cs; determination of feeding rates of soil microinvertebrates using ^{137}Cs; a litter-soil submodel for the Liriodendron forest; models for ecosystem energetics; relationship of ^{137}Cs and ^{59}Fe elimination rates to metabolic rates of small rodents; tracer studies on seasonal seed consumption and food transfer by the white-footed mouse in a forest community; nutrient dynamics in arthropod components of a grassland ecosystem; effects of soil biota on decomposition of organic matter; effects of soil biota on ^{134}Cs mobility; density and activity of soil microflora in response to herbicidal use of sodium cacodylate; effects of arsenical herbicides on a grasshopper population; inhibition of bacteria by fescue extract; analysis of a millipede population outbreak; and broomstraw invasion of fescue grass. (H.L.W.)

21622 (ORNL–4634, pp 56-70) RESPONSES OF PLANTS TO IONIZING RADIATION. (Oak Ridge National Lab., Tenn.).

From Ecological sciences division annual progress report for period ending July 31, 1970.

Experiments were conducted on retention of fallout simulants by the following agricultural plants: squash, sorghum, peanuts, and Korean clover. Two fallout simulants consisting of quartz particles 44 to 88 and 85 to 175 μ in diameter containing ^{86}Rb sorbed at high temperatures were used. Graphs are presented to show effects of wind speeds and rainfall on average retention. Results indicate that concentrations of radioisotopes can be expected to decrease at rates significantly faster than would be predicted on the basis of radiological decay. Effects of beta radiation on higher plants were investigated using soybeans. Doses of ^{90}Sr–^{90}Y β rays, ^{60}Co γ rays, and fission neutrons necessary to produce a 50% effect were calculated and RBE values were derived. Gamma and beta radiation were essentially equal in producing these end points, but fission neutrons were 6.0, 15.7, and 7.7 times more effective in producing a 50% effect on mortality, height growth, and shoot biomass respectively. Green beans were used in experiments to determine the beta radiosensitivity of various stages of the life cycle. Studies were conducted on ecological responses of yellow poplar and silver maple trees to fast neutron radiation and reduced light intensities. Results indicated that bud mortality criteria were the most reliable indices of radiation dose. Radiation damage also impaired other plant functions, such as photosynthetic capacity, root-shoot biomass balance, carbohydrate pool, and water relations. Particle retention studies on fescue grass were conducted using a fallout simulant. (H.L.W.)

21623 (ORNL–4634, pp 82-102) WATERSHED AQUATIC HABITAT INTERACTIONS. (Oak Ridge National Lab., Tenn.).

From Ecological sciences division annual progress report for period ending July 31, 1970.

An empirical watershed model was developed for studying biogeochemical relationships between aquatic habitats and associated watersheds in the Walker Branch project. The following aspects of the project are described: input-output; hydrologic analysis; water budget; and springwater quality and intrastream variation. Phosphorus-32 was used in aquatic studies on periphyton production and consumers. One of the dominant consumers was the snail, Goniobasis clavaeformis. To obtain data on ^{32}P turnover and food consumption rates of the snails feeding experiments using ^{32}P-labeled periphyton were conducted in the laboratory. Studies on macroinvertebrate populations in the stream community were conducted. A mathematical equation was developed for the diversity index, a quantitative method for analyzing community structure. Terrestrial studies were conducted on vegetation analysis; litter fall; litter decomposition and mineralization; ionic movement through the soil-water system; and soil and parent material characteristics. Red maple litter containing ^{45}Ca was used in studies on dynamics of the decomposition process and ionic movement. (H.L.W.)

21624 (ORNL–4634, pp 104-10) RADIONUCLIDE CYCLING IN AQUATIC SYSTEMS. (Oak Ridge National Lab., Tenn.).

From Ecological sciences division annual progress report for period ending July 31, 1970.

Investigations on the food habits of gizzard shad (Dorosoma cepedianum), goldfish (Carassius auratus), and bluegill (Lepomis macrochirus) in White Oak Lake were continued. The radionuclides ^{137}Cs and ^{60}Co were found consistently in the fish; however, only small quantities of ^{106}Ru, ^{125}Sb, and ^{65}Zn were found. Experiments were conducted to determine effects of temperature on elimination rates of ^{137}Cs in the bluegill. Sulfur-35 tracers were used in studies on microbial transformation of sulfurous materials in natural aerobic waters. A model was developed for studies on nitrogen fixation and cycling in producer-decomposer microcosms containing duckweed (Lemna minor) and Azotobacter chroococcum; ^{15}N was used as a tracer. Effects of nutrient-temperature interactions on aquatic animal survival were studied using carp, gambusia, and crustaceans. (H.L.W.)

21625 (ORNL-TM–2983) PROGRESS REPORT IN POST-ATTACK ECOLOGY. INTERIM REPORT. Auerbach, S. I.; Dunaway, P. B. (Oak Ridge National Lab., Tenn.). Dec 1970. Contract W-7405-eng-26. 129p. Dep. NTIS.

Separate abstracts were prepared for seven sections of the report. (H.L.W.)

For abstracts of individual sections see: 21626–21632.

21626 (ORNL-TM–2983, pp 4-26) FALLOUT SIMULANT STUDIES WITH AGRICULTURAL PLANTS. Witherspoon, J. P.; Taylor, F. G. Jr. (Oak Ridge National Lab., Tenn.).

In Progress report in postattack ecology.

Five species of agricultural plants were contaminated in the field with two particle size ranges of a quartz fallout simulant containing ^{86}Rb. Initial fallout interception and retention of particles up to 8 weeks were determined. Loss of fallout from foliage due to weathering action of wind and rain (weathering half-lives) and loss due to weathering plus radiological decay (effective half-lives) were determined for all species. Initial interception of smaller particles (44 to 88 μ dia) by foliage was 2.5 times that of larger particles (88 to 175 μ dia). Particle interception was correlated with leaf area and varied between species by a factor of 65 in terms of μCi ^{86}Rb/g foliage. After rapid initial losses of fallout (67% lost the first week after deposition), differences in retention rates between species became nonsignificant. Retention times of the two particle size ranges were also found to be similar. (auth)

21627 (ORNL-TM–2983, pp 27-46) RETENTION OF SIMULATED FALLOUT PARTICLES BY FESCUE GRASS. Dahlman, Roger C. (Oak Ridge National Lab., Tenn.).

In Progress report in postattack ecology.

Large (44 to 177 μ) fallout-simulant rubidium-86-labeled particle retention by dense fescue grass approached 50% initially, and from 1 hr to 1 day later, weathering processes decreased retention to 10%. A modified negative exponential function characterized

particle weathering over a 2 to 3 week period. Half-time for early weathering loss was 3 to 4 days, but retention approached an asymptotic level after 2 to 3 weeks, the time at which 2% of the ground surface deposit remained on vegetation. Particle deposits on leaf blades were readily removed by slight wind (<1 mph) and phytotaxic movements of the foliage. Axillary deposits, however, were not readily removed by wind and rain. (auth)

21628 (ORNL-TM-2983, pp 47-68) ^{137}Cs DYNAMICS IN A FESCUE MEADOW. Dahlman, R. C. (Oak Ridge National Lab., Tenn.).

In Progress report in postattack ecology.

Early incorporation of ^{137}Cs into foliage was largely by contact assimilation because appreciable uptake had occurred before the simulant had reached soil surface. Two loss rates (0.04 and 0.003), derived from linear regression analysis, described ^{137}Cs decrease in living foliage. The fast component characterized nuclide loss during the first month. Subsequent loss due to the slower component was an order of magnitude less than the fast rate. When evaluated over a longer time interval; i.e., 1 year, ^{137}Cs content of living foliage was expressed by a modified negative exponential, $Y = \alpha + \beta e^{\lambda t}$. Asymptotic concentration in foliage in the second growing season indicated equilibration of ^{137}Cs in the vegetative component. (auth)

21629 (ORNL-TM-2983, pp 69-86) RESPONSES OF ARTHROPODS TO IONIZING RADIATION. Styron, C. E.; Dodson, Gladys J. (Oak Ridge National Lab., Tenn.).

In Progress report in postattack ecology.

Responses of arthropod communities to ionizing radiation as it interacts with other environmental parameters are being investigated in short-term laboratory studies on interactions of fallout radiation with population dynamics of selected species, long-term field observations on interactions of simulated radioactive fallout with seasonal changes in arthropod community composition and structure, and studies of the biological and physical dosimetry of beta and gamma radiation in the fallout area. Data on the exposure of Folsomia (Collembola) to beta radiation from ^{90}Sr-^{90}Y fallout indicate that the sensitivity of the population is determined primarily by sensitivity of fertility rates rather than by sensitivity of adults. Dose rates estimated to give an LDR_{50-30} days or LDR_{50-60} days for adults are more than twice as high as dose rates required to reduce fertility to zero. A sequential three-way analysis of variance on data from a study of the effects of simulated radioactive fallout on an old field arthropod community indicated significant differences between dates and between taxa. There was no significant difference between two field enclosures before application of the fallout, but a significant difference between the control and contaminated pens did appear four months later. Lithium fluoride microdosimeters attached to grasshoppers and crickets in the fallout field indicate that these two closely related organisms receive highly significantly different radiation doses. (auth)

21630 (ORNL-TM-2983, pp 87-92) GAMMA IRRADIATION OF ARTHROPOD POPULATIONS. Van Hook, R. I. Jr.; Dodson, Gladys J. (Oak Ridge National Lab., Tenn.).

In Progress report in postattack ecology.

Effects of 5000 Rads gamma radiation delivered at five different dose rates on the survival of young adult crickets, Acheta domesticus, were determined. Significant differential mortality occurred as the dose rate was varied. Lower dose rates resulted in reduced mortality. Mortality increased with increasing dose rate up to a point above which further increases in irradiation intensity produced very similar mortality rates. (auth)

21631 (ORNL-TM-2983, pp 93-105) ^{137}Cs ACCUMULATION, DOSIMETRY, AND RADIATION EFFECTS IN COTTON RATS. DiGregorio, D.; Dunaway, P. B.; Story, J. D.; Kitchings III, J. T.; Tucker, L. E. (Oak Ridge National Lab., Tenn.).

In Progress report in postattack ecology.

Cesium-137 accumulation, dosimetry, and radiation effects were determined in cotton rats living in their natural environment contaminated with ^{137}Cs labeled sand. Cesium-137 levels were relatively high 6 months after the application of the fallout simulant, but decreased as the simulant descended toward the ground. Radioactivity levels in organs and tissues, in general, paralleled that of the whole body. Dose rate to cotton rats paralleled radioactivity levels in the whole body. No effects on the peripheral blood or body weight due to irradiation were observed in this study. (auth)

21632 (ORNL-TM-2983, pp 106-13) HONEYBEE IRRADIATION STUDIES. Shinn, A. F. (Oak Ridge National Lab., Tenn.).

In Progress report in postattack ecology.

Laboratory populations of Italian cordovan hybrid bees received acute gamma doses of 1000, 2000, and 4000 R; only the 4000 R bees had a lifespan statistically different from controls (8.9 vs 23 days, respectively). Temperature effects on lifetimes were found for laboratory-caged workers supplied with water only (2.8 days at 34°C vs 2.0 days at both 24 and 40°C) and for bees receiving queen-cage candy (13, 8, and 2 days at 24, 34, and 40°C, respectively). Field colonies were irradiated at 500, 1000, 2000, or 4000 R. Mortality of the 4000 R colonies (200 bees/day) was greater than controls (22 bees/day). Number of flights were less in the 2000 R colonies than in the 500 and 1000 R colonies. Pollen content of honeycomb was reduced in the 2000 and 4000 R colonies. Nuclei (half-size) colonies were irradiated (1500 and 3000 R) and placed in large outdoor cages. Effects were: brood counts less in irradiated colonies after 10 days; egg production less in the 3000 R colonies by day 12; and reduction in total weight of irradiated worker bees. Radiosensitivity of a mixed sample of eggs and larvae was much greater (LD_{50-4} = 1700 R) than for workers (LD_{50-5} = 16,300 R). (auth)

21633 (TID-24270) A TROPICAL RAIN FOREST. A STUDY OF IRRADIATION AND ECOLOGY AT EL VERDE, PUERTO RICO. Odum, Howard T. (ed.) (North Carolina Univ., Chapel Hill, Puerto Rico Nuclear Center, Rio Piedras), 1970. 1652p. (PRNC-138). NTIS.

Sixty-three abstracts were prepared for chapters dealing with γ radiation effects on fauna, flora, and soil in the El Verde tropical rain forest. Of the total 111 chapters included, 48 are on general ecology and have not been abstracted for NSA. (P.B.M.)

For abstracts of individual chapters see: 21247, 21447, 21548–21552, 21583, 21634–21639, 21650–21652, 21688, 21814–21820, 21839–21842, 21925–21953, and 21969–21973.

21634 (TID-24270, pp B,63-78) AERIAL SENSING AND PHOTOGRAPHIC STUDY OF THE EL VERDE RAIN FOREST. Johnson, Philip L. (Georgia Univ., Athens, Inst. of Ecology); Atwood, David M. (Army Cold Regions Research and Engineering Lab., Hanover, N. H.).

From Tropical rain forest.

Aerial and ground photographs of the El Verde rain forest site were obtained over a two-year period. They recorded the consistency of the vegetational patterns in untreated sites and the changes that occurred following γ irradiation. Four emulsions were used: panchromatic, infrared, false color, and Ektachrome. Densitometry was used to evaluate color film and the vegetation response to three months of irradiation. The color emulsions provided the sharpest indication of damage to vegetation and of the succession following treatment. Hemispherical photography of the canopy was evaluated in terms of a canopy-cover index defined as percent of light passing through the negative in a 90° cone area. Control stations were remarkably constant in all photography. This established the stability and slow change of the rain forest structure. Spectral light measurements within the forest confirmed the predominance of far-red shade light. (auth)

21635 (TID-24270, pp H,79-87) SOIL STUDIES IN THE EL VERDE RAIN FOREST. Edmisten, Joe (University of West Florida, Pensacola, Dept. of Biology).

From Tropical rain forest.

Some physical and chemical properties of tropical rain forest soils at El Verde, Puerto Rico, were investigated before and after treatments with γ radiation from a ^{137}Cs source and after mechanical defoliation of the vegetation. Flushes of soil ions were observed in soils after treatment; subsequently, ionic concentrations were lower than they were at the start. The profiles of cations indicated heterogeneous patterns with both podzolization and laterization active. Infiltration rates for the relatively undisturbed soils studied were unusually high (30 and 60 cm/hr) when associated with low bulk density. Lower infiltration rates and higher bulk-density values were associated with level areas rather than with slopes. (auth)

21636 (TID-24270, pp H,89-100) EFFECTS OF IONIZING RADIATION ON LEAF FALL, DECOMPOSITION, AND LITTER MICROARTHROPODS OF A MONTANE RAIN FOREST. Wiegert, Richard G. (Georgia Univ., Athens).

From Tropical rain forest.

The effects of ionizing-radiation stress were analyzed with respect to three major components of the detritus-decomposer food web in a Puerto Rican montane rain forest: the rate of leaf fall, the decomposition rate of leaf litter, and the density of soil litter microarthropods. The 3 month radiation stress increased the leaf fall, mostly of green leaves, in the immediate vicinity of the ^{137}Cs source. There was some indication that this increase was responsible for significant seasonal and annual differences in the calorific content of the leaf fall. No immediate effect of the

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radiation stress on the disappearance of litter from mesh bags was detected. The radiation stress has no apparent effects on the microarthropod fauna of the soil and litter. The failure reflected the low radiosensitivity of small arthropods together with the shielding effect of the soil litter habitat. (P.B.M.)

21637 (TID-24270, pp H,129-31) TRITIUM MOVEMENT IN SOIL OF A TROPICAL RAIN FOREST. Kline, J. R.; Jordan, C. F. (Puerto Rico Nuclear Center, San Juan).

From Tropical rain forest.

Triated water applied to the surface of soil in a tropical rain forest was found in free water of the litter and the top 18 cm of soil as long as 7 months after its application. It was concluded, therefore, that plant roots, even in the high-rainfall environment of a tropical rain forest, are exposed to tritiated water for a considerable time after release. (auth)

21638 (TID-24270, pp H,187-9) EFFECT OF GAMMA RADIATION ON LEACHING OF ^{137}Cs AND ^{54}Mn FROM TROPICAL FOREST FOLIAGE AND LITTER. Kline, J. R.; Odum, H. T.; Bugher, J. C. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

The effect of γ radiation on removal of fallout radionuclides by leaching from rain forest trees and litter was investigated. Samples of canopy leaves were collected from the Radiation and South Control Centers of the El Verde site both before and after irradiation with 10,000 curies of ^{137}Cs. Collections of leaf litter were made monthly before and after the irradiation for measurement of radionuclide burdens. The results from preirradiation and postirradiation collections show that radiation had no measurable effect on the rates of leaching of ^{137}Cs and ^{54}Mn from the forest canopies. The accumulation of fallout isotopes in epiphyllous plants rather than in the leaves on which they grow and the probable high resistance of these populations to radiation suggest that they may serve as mechanisms for nutrient retention during disturbances as well as in heavy rainfalls. (auth)

21639 (TID-24270, pp I,191-289) SUMMARY: AN EMERGING VIEW OF THE ECOLOGICAL SYSTEM AT EL VERDE. Odum, Howard T. (North Carolina Univ., Chapel Hill).

From Tropical rain forest.

Energy diagrams of the ecological system at El Verde summarize studies of the normal forest and its state after gamma radiation. The resulting rain forest models have large storage compartments that give stability to main power flows. The many control species, small in weight, use small energies but control the larger power flows through multiplier actions. A major part of the total forest metabolism was found in the forest floor, especially in roots. With a relatively stable regime of climate, the ecological system at El Verde receives only minor seasonal pulses of photosynthesis in the spring season to which are adapted small pulses in energy utilization for growth and reproduction through biological programming. At the Radiation Center energies previously flowing in pathways of maintenance work were diverted by species selection and other switching actions to more net growth that facilitated rapid replacement of damaged structure. After the horizontal and vertical energy patterns were changed by radiation stress, repair mechanisms routed energy reserves from the normal network into accelerated repair and recovery pathways that made the forest system more resistant to radiation than expected from initial sensitivity considerations. (P.B.M.)

21640 RADIOECOLOGICAL INVESTIGATIONS OF PLUTONIUM IN AN ARCTIC MARINE ENVIRONMENT. Aarkrog, A. (Danish Atomic Energy Commission Research Establishment, Risoe). Health Phys.; 20: 31-47(Jan 1971).

Samples of the human food chain at Thule, Greenland, were collected during the summer of 1968, after the nuclear weapon incident in January. As was to be expected from the increased plutonium levels in bottom sediments, the highest animal levels were found in bivalves, crustacea, polychaeta, and echinodermata. The levels in these bottom animals were on the average two orders of magnitude as high as the fall-out background, in a few cases four orders of magnitude. Fish from the bottom water also showed an increased plutonium content whereas seaweed, plankton, sea birds, seals, and walruses did not differ significantly from the fall-out background. The plutonium concentration in seawater was twice the fall-out background. No samples displayed plutonium levels that were considered hazardous to man or higher animals in the Thule district or in any other part of Greenland. (auth) (UK)

21641 ^{85}Kr LEVELS IN THE ENVIRONMENT DETERMINED FROM DATED KRYPTON GAS SAMPLES. Shuping, R. E. (Southeastern Radiological Health Lab., Montgomery, Ala.); Phillips, C. R.; Moghissi, A. A. Radiol. Health Data Rep.; 11: 671-2(Dec 1970).

A program to monitor the ^{85}Kr atmospheric concentrations in the United States is described, and concentrations of ^{85}Kr at several sites are presented. A brief description of the analytical method is given and values obtained are compared with those reported or predicted by others. (auth)

21642 RADIOACTIVE CESIUM IN ESTUARIES. Riel, Gordon K. (Naval Ordnance Lab., Silver Spring, Md.). Radiol. Health Data Rep.; 11: 659-65(Dec 1970).

The concentration of dissolved ^{137}Cs from fallout in the Chesapeake Bay is on the order of 0.3 pCi/liter, while the concentration is less than 0.1 pCi/liter in the rivers and ocean that supply the bay's water. The ratio of radiocesium concentration to salinity in the bay is fairly independent of location and season. Brief studies elsewhere indicate that this pattern is typical of estuaries. (auth)

21643 DISTRIBUTION AND MOVEMENT OF RADIOACTIVE NUCLIDES, BOTH NATURAL AND ARTIFICIAL, IN SOILS, VEGETATION, AND WILDLIFE. Stewart, Max Lynn. Salt Lake City; Univ. of Utah (1970). 181p. University Microfilms Order No. 70-14,444.

Thesis.

The movement and distribution of artificial ^{137}Cs, natural ^{228}Ra, and natural ^{40}K were followed through the soil profiles, vegetation, watercourses, and small animals of a forty acre study area. Mechanisms responsible for the differences in radionuclide levels are described. Erosion, irrigation, crop harvesting, flooding, grazing, and physicochemical soil factors were found to influence the movement of nuclides through soil systems. The levels of ^{137}Cs, ^{228}Ra, and ^{40}K in each centimeter increment of the thirteen 30 centimeter soil profiles are presented and discussed with respect to both vertical and horizontal distribution in the soil profiles of five different fields. The mechanisms responsible for the transport in a small creek are also described. Large amounts of ^{137}Cs were found to move down a watercourse in ionic form, adsorbed to particulate surfaces and in conjunction with organic matter. Radium-228 and K were transported down the watercourse as either an integral part of the silt physical separates or adsorbed to the surfaces of these separates. The presence of fresh fallout in the vegetation (^{95}Zr, ^{103}Ru, and ^{106}Ru) showed that fallout occurred in 1968 and again in 1969. The importance of cropping efficiency in removing ^{137}Cs from the study area is discussed. Two crops of alfalfa were found to remove more contaminants than one crop of grass hay, even though more vegetation per crop was harvested from the grass hay field. The wide range of variability of ^{137}Cs levels in vegetation was the result of crop harvesting and grazing intensity. Significant concentrations of ^{137}Cs were found to accumulate in small animals living in wet habitats, but not in small animals living in dry habitats. Several methods of reducing the levels of ^{137}Cs, which move from the environment to man and his food, are described. (Diss. Abstr. Int., B)

21644 CONCENTRATIONS OF TRACE ELEMENTS IN GREAT LAKE FISHES. Lucas, H. F. Jr. (Argonne National Lab., Ill.); Edgington, D. N.; Colby, P. J. J. Fish. Res. Board Can.; 27: 677-84(Apr 1970).

The concentration of 15 trace elements was determined by activation analysis of samples of whole fish and fish livers from three of the Great Lakes: Michigan, Superior, and Erie. The average concentrations of 7 elements in 19 whole fish from 3 species were as follows: uranium, 3 ppB (parts ber billion); thorium, 6 ppB; cobalt, 28 ppB; cadmium, 94 ppB; arsenic, 16 ppB; chromium, 1 ppM; and copper, 1.3 ppM. The average concentrations of eight elements in 40 liver samples from 10 species of fish were as follows: uranium, about 2 ppB; thorium, ≤2 ppB; cobalt, 40 ppB; copper, 9 ppM; zinc, 30 ppM; bromine, 0.4 ppM; arsenic, 30 ppB; and cadmium, 0.4 ppM. Other elements observed in most of the samples were: antimony, 5 to 100 ppB; gold, 2 to 5 ppB; lanthanum, 1 to 20 ppB; rhenium, 0.5 to 5 ppB; rubidium, 0.06 to 4 ppM; and selenium, 0.1 to 2 ppB. Trace element concentrations varied with species and lake. Uranium and thorium varied with species, but not for the same species from different lakes. The levels of copper, cobalt, zinc, and bromine varied little between species and lakes. The concentration of cadmium, arsenic, and chromium varied between species and with species between lakes. (auth) (Canada)

21645 EFFECTS OF SOIL FACTORS ON THE UPTAKE OF RADIOSTRONTIUM BY PLANTS. PART II. Lakanen, E.; Paasikallio, A. (Agricultural Research Centre, Tikkurila, Finland). Ann. Agr. Fenn., Ser. Agrogeol., -Chim. -Phys.; 9: No. 46, 133-8(1970).

The effects of increasing the contents of organic matter, clay, and inactive strontium in soil on the uptake of radiostrontium by plants are presented. The pot experiment with timothy was carried out using three entirely different soil types: Sphagnum peat,

heavy clay, and fine sand. The soils were contaminated with 40 μCi of ^{89}Sr per pot, and timothy was sown, harvested after six weeks and analyzed. In the case of inactive strontium content, there was also another portion of the soils to which 80 μCi of ^{89}Sr was added per pot and allowed to equilibrate to one half life of ^{89}Sr (53 days). The mixing of Sphagnum peat in sand reduced the plant uptake of ^{89}Sr by a factor of 7 and the ^{89}Sr/Ca ratio by a factor of 3 when the contents of soil organic carbon were increased from 1 to 15 per cent. An increase of the clay content (illite type) from 3.6 to 15 per cent reduced the ^{89}Sr/Ca ratio in the plant to a lesser extent but gave the same result at a higher clay level. The naturally high content of inactive soil strontium decreased the ^{89}Sr/Ca ratio in plants in the following order: fine sand > heavy clay > Sphagnum peat. The application of inactive strontium to previously contaminated soils reduced the ^{89}Sr/Ca ratio of the plants in fine sand and heavy clay but increased it in Sphagnum peat. (Finland)

21646 RADIOCESIUM KINETICS IN THE COMPONENTS OF A MONTANE LAKE ECOSYSTEM. Gallegos, Anthony Francisco. Fort Collins, Colo.; Colorado State Univ. (1970). 359p. University Microfilms Order No. 70-20,014.

Thesis.

Combined laboratory aquarium and lake observations with important components in the East Twin Lake (ETL) ecosystem were utilized in the synthesis of a radiocesium kinetics compartment model for predicting the build-up of this radionuclide in the tissues of fish and other components at the lake. Analysis of ^{137}Cs build-up data in fish obtained from the lake by a postulated biological model showed that the required daily intake of radiocesium was about ten times greater than that obtained from their food sources. Close to 80% of the diet of rainbow trout in ETL consisted of Gammarus lacustris, while most of the remainder consisted of Daphnia pulex. Sediment uptake by fish is postulated as the major cause of radiocesium build-up in fish at ETL, as 20 to 40% of the absorbed radiocesium is removed by the gut of rainbow trout. Qualitative identification of feldspars and quartz in the stomach and intestinal contents of rainbow trout from ETL also lends support to this theory. In addition to the compartment model synthesis for various components at ETL, a chronic ingestion model was also derived for rainbow trout at ETL utilizing the ^{137}Cs build-up data, ^{134}Cs excretion experiments in rainbow trout, and ^{134}Cs tissue distribution studies on these fish. The effects of temperature and weight of fish on the retention of radiocesium by rainbow trout were studied in a laboratory aquarium system designed to have refrigeration capacity, and to provide for treatment of solid and dissolved organic matter from fish wastes. A weight/temperature interaction term was found to affect the overall excretion pattern of radiocesium as a function of time. Retention half-times of the long component in these fish were observed to be affected not only by a weight/temperature interaction term, but also by the percent weight increase of the fish during the test interval. Laboratory experiments with Gammarus lacustris in aquaria contaminated with ^{134}Cs showed that the concentration factor of these organisms at equilibrium was largely dependent on the water radiocesium concentration. Limnological studies at ETL provided most of the necessary information required for proper description of this ecosystem in terms of radiocesium movement and pool size estimates. The total ^{137}Cs inventory of ETL was estimated to be 10 mCi. (Diss. Abstr. Int., B)

21647 PRESENT RESEARCH STATUS CONCERNING CONTAMINATION AND DECONTAMINATION OF GRAIN. Ocker, H. D. (Bundesforschungsanstalt fuer Getreideverarbeitung, Detmold, Ger.). Brot. Gebaeck; 23: No. 3, 42-8(Mar 1969). (In German).

Discussed are the mechanics by which radioisotopes, especially ^{90}Sr and ^{137}Cs, are incorporated into various types of grain. The effects of latitude, rainfall, and uptake by the root system are discussed with respect to fallout. Radioisotope contents of flour and other mill products are surveyed. ^{90}Sr is predominantly deposited in the outer layers of the grain. About 50% of this radioisotope can be removed either by dry peeling or by washing. Future developments of these procedures are outlined. (H.B.G.)

21648 NATURAL α-RADIOACTIVITY CONCENTRATIONS IN BONE AND LIVER FROM VARIOUS ANIMAL SPECIES. Cherry, R. D. (Univ. of Cape Town); Skay, M. M.; Shannon, L. V. Nature (London); 228: 1002-3(5 Dec 1970).

A comparative study is described of alpha activity in bone and liver for various species, including fish, cattle, dog, birds, man, etc. Data were obtained using the total alpha counting technique developed by Turner et al. (Brit. J. Radiol. 31: 397(1958)). All the bone samples were obtained from S. Africa. In man the greater part of the total alpha activity is found to reside in the bony skeleton, but this is not necessarily the case in other species, and measurements were made also on soft tissues. Data from the "livers" of various species showed some interesting features, although these are not necessarily to be considered representative of soft tissues in general. The data for human bones were higher than average, and might reflect real differences for different localities; for species other than man the results showed general agreement with earlier data, although wide variations were found within a single species. Man was found to be at the bottom of the activity scale, and the pig was the only other species investigated which showed a comparably low alpha activity content in both bone and "liver". Herbivore bones and marine animal livers showed an activity which was one or two orders of magnitude higher than for the corresponding human organs, and it appears that the concentrations of ^{226}Ra, and ^{228}Ra, and excess ^{210}Po must be much higher in herbivore bones than in man. In marine livers, on the other hand, it is excess unsupported ^{210}Po alone that is largely responsible for the high activity levels. Although food intake seems to be the main determinant of the α-activity of a species, there are other important factors, including a specific metabolic mechanism in marine livers, probably involving direct uptake of ^{210}Po. In this context comparisons are made between the pig and man, and it seems that food intake by itself cannot explain the concentrations of alpha emitters in biological tissues. The natural radiation dose must differ widely between different species. (UK)

21649 SPECIES DIFFERENCES IN ACCUMULATION OF ^{90}Sr AND VARIABILITY OF SMALL MAMMALS CAUGHT ON A PLACE ARTIFICIALLY CONTAMINATED WITH THIS RADIONUCLIDE. Il'enko, A. I. (Inst. of Evolutionary Morphology and Ecology of Animals, Moscow). Zool. Zh.; 47: 1695-1700(1968). (In Russian).

Differences in ^{90}Sr concentrations in small mammals are determined by their type of feeding. The highest concentration of ^{90}Sr was found in the skeleton of common shrews (Sorex) which is explained by a high intensity of metabolism in these animals and reduction of the food chain along which ^{90}Sr migrates (eating Lumbricid worms). Substantial fluctuations in the nuclide concentration in skeletons of animals of one and the same species are connected with the degree of sedentariness of individual animals. An increase in variability of population indices in sedentary rodents living in contaminated areas was found. In a migrating species (Sorex araneus) indices of variability were not changed. (auth)

Genetics and Cytogenetics

Refer also to abstracts 21534, 21576, 21620, 21677, 21701, 21720, 21922, 21957, 21959, 21965, 21980–21982, and 21997.

21650 (TID-24270, pp D,103-40) VEGETATION STRUCTURE OF A PUERTO RICAN RAIN FOREST BEFORE AND AFTER SHORT-TERM GAMMA IRRADIATION. Smith, Robert Ford (Georgia Univ., Athens).

From Tropical rain forest.

The structure of a stand of rain forest at El Verde was studied before and for one year after it was subjected to 3 months of γ radiation from a 10,000-curie ^{137}Cs source. Floristic analyses showed that the vegetation studied included both montane rain forest and tropical rain forest. Vegetation destruction, indicated by plants with leafless twigs, extended to and became relatively stabilized at 8000 R. Primary-forest species in both the canopy and the understory appear more sensitive than secondary-forest species. In the secondary-forest species, sublethal doses generally stimulated growth of twigs and production of leaves. Few malformed new leaves were observed. Root sprouting occurred only where the trunk base was shielded from direct radiation. The coverage due to seedlings and herbs in the irradiated zone was 6% after one year. Phytolacca icosandra, an herbaceous species of fully sunlit areas, was the aspect dominant after one year of recovery; it had mottled leaves, suggesting somatic mutants. (P.B.M.)

21651 (TID-24270, pp G,39-50) FERN CYTOLOGY AND THE RADIATION FIELD. Sorsa, Veikko (Helsinki Univ. (Finland). Inst. of Genetics).

From Tropical rain forest.

Postirradiation studies carried out on pteridophytes in the rain forest project area at El Verde showed that these plants are unexpectedly resistant to the radiation emitted by a cesium source. About 6 wks after the end of the irradiation period, the ferns were alive to within a distance of 3.5 m from the source (total dosage, about 800 kr), or they were dying very slowly. Cytological studies of fertile ferns and fern allies resulted in only very few disorders in cell divisions, although the nuclear volume and chromosome number are very high in these plants. Possibly some structural

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characteristic prevents breaks in the chromosomes or leads to their repair. (auth)

21652 (TID-24270, pp G,51-62) KARYOTYPE REARRANGEMENTS AND MALFORMATION OF GONADS IN THE WALKINGSTICKS (PHASMATOPTERA) OF THE EL VERDE RADIATION CENTER. Virkki, Niilo (Puerto Rico Univ., Rio Piedras, Agricultural Experiment Station).

From Tropical rain forest.

Among the walkingstick insects of the El Verde radiation area, the following 6 male karyotypes were found: Dyme krugiana Br. v. W., $24^{II} + X$; Clonistria exornata Redt., $16^{II} + X$; an unnamed but definite Lamponius species (Lamponius sp. I), $14^{II} + X$; another unnamed, definite Lamponius species (Lamponius sp. V); 2n = 36 ($17^{II} + X$); an unknown Lamponius species (Lamponius sp. III), $17^{II} + X$; an unknown species, $11^{II} + X$. Before irradiation, only one karyotype rearrangement was found; it was in an unknown species (probably conspecific with Lamponius sp. III) that was heterozygous for an autosomal centric fusion, $15^{II} + 1^{III} + X$. After 3 mon irradiation with a 10,000 curie cesium source, 6 specimens with autosomal centric fusion were encountered: two specimens of Dyme krugiana with $20^{II} + 2^{III} + X$, and 3 specimens of Lamponius sp. I, one with $12^{II} + 1^{III} + X$, two with $9^{II} + 1^{III} + X$, and one with $10^{II} + X$ (with a fusion bivalent). The last three, however, presumably belong to another species and are morphologically indistinguishable from Lamponius sp. I. Thus, only whole arm transpositions were found, and there were no heteromorphic bivalents, in contrast to earlier reports on walkingstick chromosomes. In one irradiated Lamponius sp. I, a medium-sized extra chromosome was seen. It was suggested that the 3 mon of irradiation (from January to April) resulted in extensive dying of embryos and young larvae. Of the survivors, about 80% were normal, and 18% showed gonadal malformation. (auth)

21653 INFLUENCE OF THE TEMPERATURE EFFECT BEFORE X-IRRADIATION ON THE APPEARANCE OF CHROMOSOME ABERRATIONS IN WHEAT. Babayan, R. S. Tsitol. Genet.; 4: 324-7(1970). (In Russian).

A short-term (10 min) heating of wheat seeds at 70°C (dry seeds) and 40° (soaked seeds) decreased the yield of chromosome aberrations induced by x irradiation. If the interval between heating and irradiation of seeds was prolonged, the protective effect of the former decreased. It was concluded that after thermal actions, restoration of the induced changes in seeds takes place and this leads to the change in radiosensitivity. (auth)

21654 YIELD AND QUALITY OF THE GLASSHOUSE CARNATION (DIANTHUS CARYOPHYLLUS L.) AFTER MUTAGENIC RADIATION WITH X-RAYS. Sparnaaij, L. D.; Demmink, J. F. (Inst. for Horticultural Plant Breeding, Wageningen, Netherlands). Euphytica; 19: 310-16(Aug 1970).

The effects of two doses of x rays (2.5 and 5 krad) on yield variation in clones of Sim carnations were studied for 3 years. The direct effects observed in the irradiated plants were yield reduction, reduction in flower quality and a moderate increase in yield variation. After vegetative multiplication (third year) the overall effect in yield had disappeared, flower quality continued to be adversely affected by the treatments and the increase in yield variation was more pronounced. While none of the control clones yielded outside the range $m \pm 2s$, nearly 20% of the clones from treated plants yielded outside this range. This is very significantly more than could be attributed to chance. A similar increase in variation was observed for the period of flowering as expressed by the percentage of the total yield harvested before 1st November. The increase in variation after irradiation seems to justify selection for probable mutants on the basis of clonal yield data. (auth)

21655 EFFECT OF IRRADIATION ON SOME QUANTITATIVE CHARACTERS IN BARLEY. Vasudevan, K. N.; Singh, Daljit; Nerwal, S. K. (Indian Agricultural Research Inst., Delhi). Indian J. Genet. Plant Breed.; 29: No. 1, 36-41(1969).

Variability induced in quantitative characters by five different doses of x rays at different dose rates in the M_2 generation of barley variety C138-2 was studied. Mean, variance, coefficient of variation, skewness (g_1), and kurtosis (g) for the characters yield, length of spike, and plant height were calculated. The results indicated that x irradiation of seeds particularly at higher doses induced greater variability as compared to the control. The mean yield of grains in the highest dose of 16,500 R was also significantly greater than in the control. These results are discussed in relation to the earlier reports of several workers on the induction of mutations in polygenic systems. (auth)

21656 QUANTITATIVE CHANGES IN BREEDING GROUPS OF LEBISTES AFTER IRRADIATION. Schroeder, J. H. (Inst. of Biology, Soc. for Rad. Research, Munich). Can. J. Genet. Cytol.; 11: 955-60(Dec 1969).

Neonatal guppies, Lebistes reticulatus, of a wild-colored inbred strain were x-irradiated with 1000 R, corresponding to early oogonia and spermatogonia. At sexual maturity, the irradiated fish and their sham-treated controls were mated to unirradiated guppies of another stock. The proportions of the body shape and the number of vertebrae of the F_1 and F_2 generations were determined. The quantitative characters controlled by polygenes in both experimental and control groups showed that the number of vertebrae increased in the F_1 and decreased in the F_2. The changes in body proportions reveal a trend towards a more compact type after ancestral irradiation. The variability coefficient was greater among females of the irradiated series. Shifts in the mean values were combined with alterations of viability revealing an increase in postnatal mortality and a reduction of litter size in the backcross generation. An increase in litter size and a decrease in postnatal mortality appeared in the F_1 and F_2 generations where radioinduced detrimental mutations were less likely to become homozygous. (auth) (Canada)

21657 INTERACTION OF SOME FACTORS INFLUENCING HE OXYGEN EFFECT IN IRRADIATED BARLEY SEEDS. Donaldson, Edwin. Pullman, Wash.; Washington State Univ. (1970). 124p. University Microfilms Order No. 70-16,781.

Thesis.

The roles of oxygen concentration and its interrelation with seed water content and radioinduced oxygen-sensitive site concentration on the initiation of radioinduced damage in dry barley seeds were investigated. Himalaya (CI 620) barley seeds were adjusted to water contents ranging from 2 to 14%. The seeds which had been treated with ^{60}Co γ rays while in evacuated glass vials or in pressure chambers at one of several oxygen pressures were hydrated at 0°C in water bubbled with gas containing oxygen concentrations of 0.0, 3.1, 6.25, 12.5, 25, 50, and 100%. Biological effects were recorded as M_1 seedling injury and chromosome aberration frequencies. The results are explained on the basis that oxygen reacts with radioinduced oxygen-sensitive sites (OSS) or, presumably, free radicals. (Diss. Abstr. Int., B) (TSS)

21658 TRENDS IN THE UTILIZATION OF RADIATIONS AND RADIOISOTOPES. APPLICATIONS IN AGRICULTURE. Shibuya, Masao (National Inst. of Agricultural Sciences, Tokyo). Genshiryoku Kogyo; 16: No. 4, 104-6(Apr 1970). (In Japanese).

The utilization of radioisotopes and radiation in agriculture in Japan has been pursued from a long-range point of view. The techniques are now a practical reality, being extended past laboratory and pilot investigations. The applications of radioisotopes and radiation in agriculture, including the past, present and future, are reviewed in the following: irradiations, dealing with breeding of new species and food irradiation; tracers, dealing with the improvement in growing rice, fruit trees, forest, etc., improvement of vegetable species, and species development etc.; and activation analysis, dealing with trace elements in plant, soil, etc., also in association with public hazards. (Japan)

21659 ADVANCES IN HUMAN GENETICS. VOLUME 1. Harris, Harry; Hirschhorn, Kurt (eds.). New York; Plenum Publishing Corporation (1970). 349p.

A separate abstract was prepared on one chapter that discusses autoradiographic techniques. Four additional chapters discuss the analysis of pedigree data, the genetics of immuno-globulins, the genetics of membrane transport, and the genetics of disorders of intestinal absorption and digestion. (C.H.)

For abstract of individual chapter see: 21534.

21660 INTERACTION OF TWO DOSES OF GAMMA-RAYS IN THE COURSE OF IRRADIATION OF AIR-DRY AND SOAKED SEEDS OF CREPIS CAPILLARIS. Abilov, A. N. (Inst. of General Genetics, Moscow). Genetika; 7: No. 2, 80-5(Feb 1971). (In Russian).

In the course of studying the consequences of the treatment of Crepis capillaris seeds with gamma-rays at two doses a distinct evidence of the interaction of these doses could be obtained, provided the first of these doses was applied to air-dry seeds while the other one was used for the treatment of the seeds after they were soaked. The character of this interaction was different, depending on the period of the stage G_1 or the stage S during which the treatment was applied. When both doses were applied at the beginning of a stage (any stage, G_1 or S of the first mitosis), the effect of the combined irradiation was higher than the total effect of treatment applied throughout all the stages of the mitotic cycle of mitosis I. When both treatments were applied at any other period of these stages, the effect of the combined fractionated irradiation was lower than this total effect. The x-ray treatment of

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air-dry seeds at a 500 R dose induced only chromosome aberrations. In the case of a combined irradiation there was an interaction between the first and the second doses in the course of the induction of chromosome aberrations. In the case of the treatment of air-dry seeds with gamma-rays at a 5000 R dose inducing under these conditions only chromosomal aberrations, an interaction of this process with those leading to chromatid aberrations appearing after the seeds were exposed to the second dose (1000 R) after 12 hours' soaking takes place. (auth)

21661 INDUCTION OF CHLOROPHYLL MUTATIONS IN BARLEY BY A COMBINED TREATMENT OF SEEDS WITH GAMMA-QUANTS AND DIFFERENT CONCENTRATIONS OF ETHYLENE-IMINE. Avetisov, V. A.; Valeva, S. A. (Inst. of General Genetics, Moscow). Genetika; 7: No. 2, 30-2(Feb 1971). (In Russian).

The mutagenic effect of ethylene-imine on barley seeds was enhanced by a preliminary gamma-irradiation. The irradiation (at a low dose) of barley seeds previously treated with ethylene-imine at a low concentration decreased the mutagenic effect of ethylene-imine. (auth)

21662 EXPERIMENTAL INDUCTION OF MUTATIONS AFFECTING THE UPTAKE OF ^{90}Sr IN THE ISKRA VARIETY OF WHEAT. Kal'chenko, V. A. (Inst. of General Genetics, Moscow). Genetika; 7: No. 2, 33-8(Feb 1971). (In Russian).

An increase of the range of variation of the rate of ^{90}Sr accumulation in the grains of wheat (cultivar Iskra) was shown to be induced by mutagenic factors. Three mutant families were selected in which the rate of uptake of the Sr isotope in the grain is but one half that in the initial variety. This difference at first recorded in M_3 among the families not differing morphologically from the initial variety persists in M_4 and M_5 under both field and greenhouse conditions. The families selected differ from the initial variety by a lower (by 25 to 30%) content of Sr units in the grains; not differing, however, by the ^{90}Sr content in other organs (stem, leaves). In the course of transition of ^{90}Sr and Ca from certain plant organs to other organs along the chain: vegetative organs → grain in mutant families, Ca discriminates ^{90}Sr considerably more than in the initial cultivar. (auth)

21663 DEPENDENCE OF THE UV-SENSITIVITY OF THE PHAGE T4 ON THE LOCATION OF THE CONDITIONALLY LETHAL (AMBER) MUTATIONS IN THE GENOME. Azizbekyan, R. R. (Inst. of Genetics and Selection of Industrial Microorganisms, Moscow). Genetika; 7: No. 2, 133-8(Feb 1971). (In Russian).

The effect of am-mutants in different genes of the phage T4 on the uv-sensitivity in the case of development in a non-permissive strain was studied. Am-mutants in the genes 30, 42, 43, 44, 45, 46, 47, and 63 increased the sensitivity to the uv-light while such conditionally-lethal mutations in the genes 1, 18, 31, 32, 41, 52, 55, and 56 did not affect the radioresistance. Possible mechanisms of this phenomenon are discussed. (auth)

21664 INDUCTION OF MITOTIC RECOMBINATION IN YEAST BY THE DECAY OF THE INCORPORATED PHOSPHORUS ISOTOPE ^{32}P. Korolev, V. G.; Gracheva, L. M. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika; 7: No. 2, 147-53 (Feb 1971). (In Russian).

The induction of mitotic crossing-over by the decay of ^{32}P incorporated into the cells of Saccharomyces cerevisiae was studied. A diploid strain of yeast heterozygous for ad_1 and ad_2 was used. The frequency of homozygotes for ad_1 and ad_2 increased with the increasing number of decays and attained the plateau level at approximately 200 decays. The maximal probability of recombination per one decay equals 0,033. A positive correlation between the frequencies of homozygotes for ad_1 and ad_2 and the distances of these loci from their centromeres was observed. (auth)

21665 MODIFICATION OF THE RADIATION EFFECT BY DEOXYADENOSINE AT THE STAGE G_1 IN CREPIS CAPILLARIS. Otradnova, V. V.; Mitrofanov, Yu. A. (Inst. of General Genetics, Moscow). Genetika; 7: No. 2, 167-9(Feb 1971). (In Russian).

The modification of the effects of x rays in Crepis capillaris by adenosinedeoxyribose (AdR), an inhibitor of DNA synthesis, was studied. A significant sensitizing effect of AdR with respect to the induction of chromosome rearrangements was observed when the cells were irradiated at the G_1-stage and the AdR was injected during both stages, G_1 and S. The frequency of chromosome-type rearrangements was two-fold or more. No effect of AdR was observed in the case of its injection only at the G_1-stage into the cells irradiated at that stage; when AdR was applied to such cells only at the S-stage its effect was slight. (auth)

21666 TYPE OF FREE RADICALS AND CHROMOSOMAL ABERRATIONS INDUCED BY GAMMA RAYS AS A FUNCTION OF THE PHYSIOLOGICAL STATE OF SEEDS. Nuzhdin, N. I.; Samokhvalova, N. S.; Sheksheev, Z. M. (Inst. of Biophysics, Pushchino-Na-Oke, USSR). Dokl. Akad. Nauk SSSR; 191: 1410-12(21 Apr 1970). (In Russian).

Barley seeds in a natural state of rest and in a forced state of rest were given a 15 kr dose of gamma radiation from a Cs-137 source. The moisture content of both groups of seeds was 7 to 8%. The state of free radicals in the seeds was followed by using the method of electron paramagnetic resonance (EPR). These changes were compared with changes in the frequency of chromosomal aberrations. The results showed that the number of chromosomal aberrations in the cells were inversely proportional to the intensity of the EPR signal in the kernel. Thus the existence of free radicals in the seeds can be considered as a source of potential damage to the chromosomes. The seeds in a forced state of rest had a higher content of oxygen, showed fewer radicals and had a greater number of chromosomal aberrations than the seeds in a natural state of rest. (TTT)

21667 ABNORMAL RECOMBINATION FREQUENCIES BY UV-RADIOSENSITIVE MUTANTS OF ASPERGILLUS NIDULANS. Jansen, G. J. O. (Genetisch Instituut, Utrecht). Genen Phaenen; 13: No. 2, 14-15(Nov 1969). (In Dutch).

The abnormal recombination frequencies of uvsB10 and uvsC14 mutants of Aspergillus nidulans were studied. Resting uvsC14 conidia are more sensitive to uv radiation than resting usvB10. The frequency of spontaneous mitotic recombinations of the pabaA locus in a uvsB10/uvsB10 diploid is five times higher and in a uvsC14/uvsC14 diploid eight times higher than in uvs^+/uvs^+ and uvs^+/uvs diploids under similar conditions. (J.S.R.)

21668 RESISTANCE OF MATURE OOCYTES OF DROSOPHILA MELANOGASTER TO THE INDUCTION OF NON-DISJUNCTION BY X-RAYS. Traut, H. (Univ., Muenster, Ger.). Mutat. Res.; 10: 156-8(Aug 1970).

Experiments were done on the resistance of mature oocytes of Drosophila melanogaster to the induction of non-disjunction by x rays. It was found that mature oocytes were more sensitive to induction than immature oocytes. Results show that the differential sensitivity of oocytes is caused exclusively by differential induction of chromosome losses. (P.B.M.)

21669 MITOTIC G_2 DELAY INDUCED IN SYNCHRONIZED HUMAN KIDNEY CELLS BY UV AND X-IRRADIATION AND ITS RELATION TO DNA STRAND BREAKAGE, REPAIR, AND TRANSCRIPTION. Scaife, J. F. (Euratom Joint Research Centre, Varese, Italy). Cell Tissue Kinet.; 3: 229-42(Jul 1970).

Synchronous populations of human kidney T-cells were used to investigate the influence of BUdR incorporation into DNA on mitotic G_2 delay produced by uv or x irradiation. By this means true G_2 delay could be distinguished from a prolongation of the S-phase. X ray induced mitotic delay is only slightly increased in BUdR containing cells. Ultraviolet induced mitotic delay is appreciably augmented in cells having incorporated BUdR. These cells show extensive single strand breaks in their DNA that is fairly rapidly repaired. Transcription and translation are also appreciably reduced following uv in such cells. It is concluded that mitotic inhibition following x irradiation is a result of mechanisms other than the damage to and repair of DNA while mitotic inhibition following uv irradiation is primarily related to DNA damage and repair. The specific division proteins synthesized in G_2 in these cells constituted only a minor component of the total soluble cell proteins. (auth)

21670 RADIOSENSITIVITY AND MUTABILITY OF THE FORAGE PEA. I. EFFECT OF THE TOTAL DOSE AND INTENSITY OF γ IRRADIATION. Vasileva, M.; Mekhandzhiev, At. (Inst. of Genetics and Plant Breeding, Sofia). Genet. Selek.; 2: 215-26(1969). (In Bulgarian).

Results are presented from investigations on the effect of the total dose and intensity of gamma irradiation on the growth and development of the plants, induced chromosome aberrations, and relationship between growth manifestations and abnormalities in the chromosomes. Dry seeds with 12 percent moisture content were ^{60}Co γ irradiated in doses of 1, 5, 10, 15 and 20 kR at two intensities (49 and 1860 r/min). The following more important conclusions are drawn: Irradiation of dry pea seeds with ^{60}Co gamma rays in all doses at greater intensity leads to increased chromosome aberrations and more strongly inhibited processes of growth. A dose of 1 kR applied at low intensity (49 r/min) shows some stimulation effect. Doses of over 10 kR decrease the percentage of sprouting and inhibit the plant development. A positive correlation is found between induced chromosome aberrations at the first mitosis and inhibited growth of the sprout. (auth)

21671 RADIOSENSITIVITY AND VARIATIONS IN MUTATIONS DURING CHRONIC γ-IRRADIATION. Kalyaskina, T. V.; Tarnakina, L. G. (All-Union Botany Inst., Moscow). Vestn. Sel'skokhoz. Nauki (Moscow); No. 12, 40-6(1969). (In Russian).

Two species of wheat having different chromosome numbers were treated with chronic γ radiation. Growth and development of F_2 plants were greatly inhibited. There was a greater frequency and variety of mutations in the Diamont variety of soft wheat than in Triticum monococcum. (H.L.W.)

21672 CYTOMORPHOLOGICAL CHARACTERISTIC OF RADIATIONAL MUTANT OF BARLEY MB-1. Volodin, V. G.; Lisovskaya, Z. I.; Kartel, N. A.; Krasulevich, L. A. (Inst. of Genetics and Cytology, Minsk). Tsitol. Genet; 4: 328-33(1970). (In Russian).

From a two-rowed variety of barley, Erektum 106, a multi-rowed radioinduced mutant that had valuable characteristics was obtained. The mutant origin of the new form was verified by the demonstration of meiotic anomalies. Multi-rowed ears developed from glumes of basic flowers instead of from lateral flowers as is the case with ordinary multi-rowed barleys. Progression of meiotic stages was hindered by the development of additional flowers in the mutant variety; decreased production of anthers and pollen grains was also attributable to this mechanism. Grain setting in additional flowers was not high and varied significantly in ears from different plants. It was concluded that the new mutant, MB-1, was valuable as starting material for further selective work. (auth)

21673 CHROMOSOME ABERRATIONS IN VICIA FABA SEED ROOT CELLS UPON COMBINED TREATMENT WITH COLCHICINE AND X RAYS. Aiyash, Kh. (Leningrad State Univ.). Tsitologiya; 12: 1464-70(Nov 1970). (In Russian).

The effect of a preliminary colchicine treatment (0.005% concentration) on results of a consequent x-irradiation of the Vicia faba seed roots was examined. The number of chromosome aberrations was reduced at all the stages of the mitotic cycle. A possible relation of this effect to changes in the degree of chromosome spiralization due to colchicine treatment is discussed. (auth)

21674 DOUBLE SPIKE: A RADIOMORPH IN WHEAT AND BARLEY. Gill, Khem Singh; Sethi, Gurdip Singh (Punjab Agricultural Univ., Ludhiana, India). Indian J. Genet. Plant Breed.; 29: No. 1, 135-8(1969).

It was observed that the character of double spike (two spikes on a single peduncle) could be induced in barley and wheat using EMS, ^{32}P, and gamma radiation. Experiments were conducted to determine whether this character was a mutation or a radiomorph. Seeds of both plants were treated with various doses of ^{60}Co γ rays, ^{32}P in various solutions, and various concentrations of EMS. Tables are presented to show the number of plants developing from treated and untreated seeds and the number of plants with the double spike in the first and second generations. Since the character was not expressed in the second generation, it was concluded that the character was a radiomorph rather than a mutation. (H.L.W.)

Health Physics and Safety

Refer also to abstracts 21205, 21231, 21276, and 21279.

21675 (NP-18630) ACTIVITY REPORT OF THE FEDERAL HEALTH OFFICE FOR THE YEAR 1968. (Bundesgesundheitsamt, Berlin (West Germany)). 296p. (In German). Dep. NTIS (U. S. Sales Only).

Reported are activities of the Robert Koch Institute, the Institute for Environmental Damage and Civilization Diseases, Max von Pettenkofer Institute, and the Government Health Institute. General aspects of medicine, biochemistry, physiology, pharmacology, and chemistry are discussed as well as participation in international meetings and research projects. A separate abstract was prepared for the activities of the Institute for Water-, Soil-, and Air Hygiene. (H.B.G.)

For abstract of individual section see: 21677.

21676 (NP-18631) ACTIVITY REPORT OF THE FEDERAL HEALTH OFFICE FOR THE YEARS 1966 AND 1967. (Bundesgesundheitsamt, Berlin (West Germany)). 332p. (In German). Dep. NTIS (U. S. Sales Only).

Reported are activities of the Robert Koch Institute, the Institute for Environmental Damage and Civilization Diseases, Max von Pettenkofer Institute, and the Government Health Institute. General aspects of medicine, biochemistry, physiology, and pharmacology are discussed as well as participation in international meetings and research projects. A separate abstract was prepared for the acitivities of the Institute for Water-, Soil-, and Air Hygiene. (H.B.G.)

For abstract of individual section see: 21678.

Radioactive Contamination and Decontamination

Refer also to abstracts 21266, 21615, and 21640.

21677 (NP-18630, pp 103-11) INSTITUTE FOR WATER-, SOIL-, AND AIR HYGIENE. SECTION V. RADIATION PROTECTION AND RADIATION BURDEN. (Bundesgesundheitsamt, Berlin (West Germany)). (In German).

In Activity report of the Federal Health Office for the year 1968.

Because of understaffing, the institute could proceed only partially with the study of radiation burden to the population. Evaluation of literature and data was continued. Briefly summarized is progress in radiology, dosimetry and radiation physics, natural and artificial radioactivity, mathematical analysis and experimental design for radiation burdens, radiobiology, radiochemistry, and radiation genetics. (H.B.G.)

21678 (NP-18631, pp 122-35) INSTITUTE FOR WATER-, SOIL-, AND AIR HYGIENE. SECTION V. RADIATION PROTECTION AND RADIATION BURDEN. (Bundesgesundheitsamt, Berlin (West Germany)). (In German).

In Activity report of the Federal Health Office for the years 1966 and 1967.

Because of limitations in space and personnel, experimental studies of the institute were of a preliminary nature. Emphasis resided in the evaluation of information and measuring data concerning radiation burden to the population. The major work consisted in the accumulation and review of pertinent literature. In addition, the institute formulated more than 50 directives for situations such as rooms for autopsies of contaminated corpses, dose levels for populations adjacent to nuclear installations for normal operation and accidents, contamination and incorporation of tritium during the manufacturing of fluorescent paints, and safety of nuclear power plants in the state of design and construction. Briefly discussed were radiology, dosimetry and radiation physics, natural and artificial radioactivity, radiation burden and data tabulation, radiochemistry, and radiation genetics. (H.B.G.)

21679 PUBLIC HEALTH IMPLICATIONS OF RADIOACTIVE WASTE RELEASES. Straub, C. P. Geneva; World Health Organization (1970). 61p. $1.75.

Radioactive wastes present special public health problems that are not common to other wastes and are unfamiliar to many health authorities. Difficulties arise from the fact that there is no method of neutralizing or modifying the radioactivity of the wastes. Their decay rate is fixed, being a specific, invariable property of each radionuclide. Furthermore, most radioactive wastes contain a low concentration of radionuclides and are usually disposed of by dilution into the environment. Once they have been discharged into the environment, in accordance with statutory limitations, no significant further control can be practiced; they undergo dilution, retention, and reconcentration through the operation of natural processes, and continue to be a potential hazard to man. The sources of radioactive wastes are discussed and methods used for collecting and sampling these wastes are described. Disposal methods, including dilution and dispersion; concentration and confinement; and delay and decay are discussed with respect to their potential for the release of radioactivity to the atmosphere, to the soil, and to ground and surface waters. (90 references) (C.H.)

21680 NATURAL RADIOACTIVITY IN FOOD PRODUCTS IN A REGION WITH INCREASED NATURAL RADOACTIVE BACKGROUND. Mihailov, M. G.; Jotov, M.; Yanackova, M.; Petkov, T. Rentgenol. Radiol.; 6: No. 4, 236-9(nd). (In Bulgarian).

The natural radioactivity of food products in a region of high gamma background was measured. The content of certain natural radioactive elements, such as uranium, radium-226, potassium-40, and the total beta activity is specified. The investigated region was of an average two to three times higher than the control region. Greatest differences for radium-226 were found in cabbage and beans (15 to 20 times) and for uranium in cabbage (15 times). With regard to potassium-40, no marked differences were observed. Total beta activity was highest in corn (15 times). Of the examined samples of water taken from different water sources, greatest radioactivity was found in the spring water of the region

with increased radioactive background. (Abstr. Bulg. Sci. Med. Lit.)

21681 DEACTIVATION OF SURFACES CONTAMINATED WITH THORIUM ISOTOPES AND ITS DISSOCIATION PRODUCTS. Cherkashina, T. N.; Pavlovskaya, N. A.; Moiseitsev, P. I. Gig. Sanit.; No. 10, 33-7(Oct 1970). (In Russian).

The contamination of various materials contaminated with thorium isotopes and its decay products was investigated. A short-lived isotope, lead-212, proved to be more firmly absorbed. The long-lived isotopes as thorium-228 and radium-224 were considerably more easily eluted. On the porous surfaces (linoleum, ceramic tile) both the short- and long-lived isotopes remained. (auth)

21682 RADIOPROTECTIVE SURVEY OF THE MAIN DRAINAGE CHANNEL OF THE REACTOR CENTER SEIBERSDORF. Wanderer, E. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Isotope Ind. Landwirt.; 7: No. 1, 14-19(1970). (In German).

In the radioprotective control of Reactor Center Seibersdorf surroundings, regularly testing of the main drainage channel for contamination is a main task. Three times a year the following samples are taken: mineral sediment, rotting silt, core samples, algae (Cladophora), Fonitalis, moss, crabs (Gammarus pulex), and fish. Samples are taken along a testing range from 100 m above the inlet to 5000 m downstream of the inlet. After preparation (reduction to ashes), 1g of ash is measured for its gross β activity, as well as for its γ spectrum. Measuring results range in the limits from 10 to 100 pCi/g sediment, a maximum is observed regularly just below the inlet system and within the weir in Wasenbruck 3000 m downstream. The same maxima are observed in the activity curves of algae and crabs. Laboratory experiments on the sorption capacity of the different grain sizes showed a maximum in the fractions at 100 to 75 μ of mineral sediment and at 30 to 15 μ of rotting silt. These two fractions constitute up to 67% of the total suspended load, which indicates good conditions for a high self-cleaning rate. (auth) (INIS)

21683 DECONTAMINATION OF GRAIN. Pelshenke, P. F.; Ocker, H.-D.; Bolling, H.; Zwingelberg, H. (Bundesforschungsanstalt fuer Getreideverarbeitung, Detmold, Ger.). Getreide Mehl; 19: No. 5, 36-40(May 1969). (In German).

By removing the husk of wheat and barley, 40 to 50% of ^{90}Sr, 20% of ^{54}Mn, and 10% of ^{137}Cs are eliminated. Since the husk contains most of the ^{90}Sr accumulated through external contamination and uptake through roots, decontamination by wet-peeling is effective. Treatment with sodium hydroxide is not as effective for decontamination as is dehusking. (H.B.G.)

21684 THYROID NODULARITY IN SOUTHWESTERN UTAH SCHOOL CHILDREN EXPOSED TO FALLOUT RADIATION. Weiss, Edward S. (Univ. of Missouri, Columbia); Rallison, Marvin L.; London, W. Thomas; Thompson, G. D. Carlyle. Amer. J. Public Health; 61: 241-9(Feb 1970).

Thyroid nodularity was found with equal frequency among children potentially exposed and those not exposed to fallout radiation in Southwestern Utah. There are acknowledged limitations to the interpretations of these data: although iodine-131 fallout did occur with other nuclides, the exact concentrations, the details of geographic distribution, and the individual circumstances of transport to children primarily via milk are not known; the method utilized for detection of thyroid nodularity (neoplasms) is not highly precise; and a relatively short (and perhaps inadequate) period of time has elapsed between potential exposure and the examinations. Within the limitations of the study, however, there is no evidence that children of Southwestern Utah and adjacent areas of Nevada near the test site have received enough radiation from radioiodine to produce significant thyroid disease. (auth)

Dosimetry and Monitoring

Refer also to abstracts 20940, 21379, 21403, 21450, 21451, 21641, 21648, 21904–21906, 21918, 21923, 22302, and 22584.

21685 (ANL-7760(Pt.2), pp 36-44) MEASUREMENTS OF ^{241}Am IN TWO SUBJECTS. Rundo, John; Keane, A. T.; May, H. A. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969–June 1970.

A scientist worked in the detached garage of his home for a period of 3 months with a source of ^{241}Am of supposed strength about 10 mCi. The americium was reported by the supplier to be safe and not to release activity on smearing. The scientist's 4-year old son followed the proceedings attentively. Six years later α-particle contamination at the scientist's new place of employment was identified as ^{241}Am, and its origin was eventually traced to contaminated furniture and fittings in his new home. Body radioactivity measurements demonstrated the presence of ^{241}Am in all members of the household, but at levels of concern only in the scientist and his son (now aged 10). Confirmatory whole-body measurements of the levels in these two subjects indicated the ^{241}Am content of the scientist and his 10-year-old son were 60 nCi and 40 nCi, respectively. The calibration methods are described in some detail. (C.H.)

21686 (CONF-700816-(Vol.2), pp 832-6) INVESTIGATION OF A NUCLEAR FUEL REPROCESSING PLANT UPON ITS ENVIRONMENT. Smith, D. G. (Bureau of Radiological Health, Winchester, Mass. Northeastern Radiological Health Lab.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

To prevent unnecessary expenditures on hastily conceived environmental sampling and monitoring programs around the several planned nuclear fuel reprocessing plants, the Division of Environmental Radiation of the Bureau of Radiological Health has a project for development of a recommended methodology to enable agencies to carry out their responsibilities economically and accurately with a minimum of cost or inconvenience to the operators of these facilities. The objectives of this study are: To develop minimum and optimum requirements for environmental surveillance programs around nuclear fuel reprocessing plants; to develop a uniform set of surveillance methods that can be adopted by other states and companies in meeting surveillance needs; to identify specific radionuclides that may be released in liquid and gaseous waste discharges and the pathways by which they are dispersed in the environment; and to relate the levels of released radionuclides to levels in critical pathways in order to specify the most beneficial sampling and analyses to perform. (auth)

21687 (CONF-700834-(Absts.)) TENTH CONFERENCE ON PHYSICS IN MEDICINE AND BIOLOGY, MELBOURNE, 24th–28th AUGUST 1970. Notes to Delegates and Abstracts. ([Australian Atomic Energy Commission]). 20p.

Abstracts of 38 papers are presented. Topics include the effects of γ radiosterilization on the mechanical behavior of human tendons; differential W values in dosimetry, in relation to the Hurst–Ritchie principle of radiation dosimetry; physical factors in radium and radon γ dosimetry; the A.A.E.C. program in micro-calorimetry for absolute dose measurement; a comparison of dosage standards; research, development and production of pharmaceuticals labeled with the short-lived radioisotopes ^{18}F, ^{131}I, or ^{99m}Tc; various aspects of radioisotope body scanning; the design of a nuclear cardiac pacemaker battery that uses tritium as the energy source; radiation sources and computer applications in radiotherapy; thermoluminescent dosimetry in diagnostic radiology; radionuclide purity; radioactivity standards; radioactive material packaging; and tracer techniques. (Australia)

21688 (TID-24270, pp C,41-7) PATTERNS OF RADIATION EXPOSURE IN THE TROPICAL RAIN FOREST. McCormick, J. Frank (North Carolina Univ., Chapel Hill, Dept. of Botany).

From Tropical rain forest.

The pattern of γ radiation received in the rain forest at El Verde was monitored by 1450 lithium fluoride dosimeters dispersed in horizontal and vertical patterns about the 10,000-curie ^{137}Cs source during the 92-day exposure period. Although the geometry of the area exposed was extremely heterogeneous because of ravines, trees, and rocks, the radiation field became symmetrical beyond 30 m. At this distance vegetation and terrain did not provide significant radiation shielding since much of the radiation received was from scatter and sky-shine. Within the 30-m radius, rocks and trees provided up to 40-fold reduction in exposure dose to microhabitats. Because of a lead plug above the ^{137}Cs source, tree crowns directly above the source received less radiation than tree crowns farther away. (auth)

21689 UNIFIED APPROACH TO DOSIMETRY PROBLEMS IN RADIOLOGICAL PROTECTION. Burlin, T. E. (Polytechnic of Central London); Wheatley, B. M. Phys. Med. Biol.; 16: 47-56(Jan 1971).

The dose equivalent per unit fluence in various organs is calculated for mono-directional incident radiation. From this the fluence which will produce the maximum permissible annual organ dose recommended by ICRP is determined. By using the simple parameters of number and energy of quanta, which can describe all radiations, the proposed method avoids the difficulties of present practice which relies on various units for different radiations. Practical applications of the method are given, and it is shown that

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it is simple to relate the calibration of instruments based on the method to existing radiological standards. (auth) (UK)

21690 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 11: 673-85(Dec 1970).

The average concentrations of ^{90}Sr, ^{131}I, and ^{137}Cs in milk from State and Pasteurized Milk Network, Pan American Milk Sampling Program, and Canadian Milk Network sampling stations are reported for August 1970 and for the twelve-month period up to this date. Sampling stations are located throughout Canada, United States, and Central and South America. Radiation Protection Guide and Protective Action Guide values for radioisotope content of milk are given to place the sample values in perspective. The estimated daily intake of ^{90}Sr and ^{137}Cs in a standard diet was determined by the Connecticut State Department of Health for July to December 1969. General trends for intake of these radioisotopes are evaluated graphically for the period during 1963 to 1969. All other milk and diet data are presented in tabular form. (E.R.B.)

21691 DATA. SECTION II. WATER. Radiol. Health Data Rep.; 11: 687-94(Dec 1970).

Interstate carrier water supplies were sampled at stations in 31 states and the results of radiological analyses are reported for a 3-yr period from 1967 through 1969. The samples were analyzed for gross α and β radioactivity and ^{90}Sr, ^{226}Ra, and total Ra concentrations. The data for each sampling station are presented in tabular form. A second table contains a summary of the data for all stations during the same period. The standards for drinking water in relation to each radioisotope and the gross radioactivities are presented for comparison. The tritium content of community water supplies during 1969 in 13 selected states was determined. The data presented for each sampling station include the collection date, sample source, water type and source, and tritium content. All samples contained less than 0.3% of the tritium content allowed by the FRC radiation protection guide. (E.R.B.)

21692 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 11: 695-700(Dec 1970).

The gross β radioactivity in surface air particulates and deposition by precipitation during August 1970 was determined from samples obtained at selected sites throughout the United States by the Radiation Alert Network. The data, in tabular form, include maximum, minimum, and average values for each station and a summary of values for all stations. All field estimates reported were within normal limits for the stations. Graphs showing monthly and yearly profiles of β radioactivity in atmosphere during 1964 to 1970 for eight selected stations on the network are also included. The Canadian Air and Precipitation Monitoring Program monitors the gross β radioactivity in surface air and precipitation at 23 sites throughout Canada. The data obtained from samples collected during August 1970 are presented. Data on the gross β radioactivity in surface air of Central and South America during August 1970 are presented. The data were obtained from samples collected at the 12 stations on the network of the Pan American Air Sampling Program. (E.R.B.)

21693 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 11: 701-15(Dec 1970).

Environmental radioactivity levels at Mound Laboratory and the Savannah River Plant are reported for July through December 1969. At both installations, environmental radioactivity levels during this period were below the limits established by the AEC. Environmental and effluent monitoring activities at the SIC Prototype Reactor Facility indicated that during 1969 the environmental radioactivity levels did not at any time exceed preoperational levels. It was announced by the AEC that one low to intermediate level underground nuclear test was conducted at the Nevada Test Site during November 1970. Seismic signals equivalent to those of a nuclear test of the low to intermediate yield range, originating presumably from the Soviet underground nuclear test area, were recorded on November 4, 1970. (E.R.B.)

21694 DOSE FIELDS IN DIFFERENT PARAMETERS OF SCREEN DIAPHRAGMS IN TELEGAMMATHERAPY. Aliev, B. M.; Galina, L. S. (All-Union Inst. of Radiation Techniques, Moscow). Med. Radiol.; 6: No. 1, 61-9(Jan 1971). (In Russian).

The ^{60}Co γ dose fields during the use of nine experimental lead screen diaphragms and the influence of geometrical parameters of screens on the characteristics of dose fields were investigated. The absolute dose value, irregularity coefficient, and value of integral doses were determined. A comparison was made of the value of integral doses of irradiation in the use of screen diaphragms and in open field irradiation. Recommendations on the choice of parameters of the screen for maintaining the necessary coefficient of dose irregularity are given. (auth)

21695 METHOD OF CALCULATION OF THE DOSE FIELD UNDER THE SCREEN IN GAMMATHERAPY. Devyatykh, Yu. N.; Morozov, A. I. (Scientific-Research Clinical Inst., Moscow). Med. Radiol.; 6: No. 1, 69-74(Jan 1971). (In Russian).

A method of calculation of the therapeutic dose of γ radiation under a lead grid is described that is based on laws of geometrical optics and the dose decline with increase of the distance from the source and thickness of the grid. Calculations correlate well with experimental data published in the pertinent literature. (auth)

21696 CALCULATION OF THE INCLINATION OF THE ISODOSE CURVE IN THE USE OF A WEDGE-LIKE FILTER. Galina, L. S. Med. Radiol.; 6: No. 1, 75-9(Jan 1971). (In Russian).

Methods are described for the calculation of the inclination angle of the isodose curve in the use of wedge-shaped filters. For therapeutic doses of ^{60}Co γ radiation with the use of a lead filter the correlation between the inclination angle of the isodose curve and angle of the wedge situated at various distances from the source was determined. The effects of inclination of the irradiated surface to the beam axis was also determined. The correlations were verified experimentally. (auth)

21697 DOSIMETRY WITH HIGH ENERGY ELECTRONS. Vogel, K.-H. (Univ., Tuebingen, Ger.). Roentgenpraxis; 23: 236-42(Oct 1970). (In German).

Dosimetry methods for high-energy electrons are described and compared. Ionization, calorimetric, luminescence, chemical, and photographic methods are considered. 33 references are given. (H.B.G.)

21698 MEASUREMENT OF THE STATE OF EQUILIBRIUM BETWEEN RADON AND ITS DAUGHTER PRODUCTS IN URANIUM MINES. Lopez, Alain (Faculte des Sciences, Toulouse); Chapuis, Alain; Fontan, Jacques; Billard, Francois; Madelaine, Guy J. Aerosol Sci.: 1: 255-64(Aug 1970). (In French).

Two methods are presented for measuring the radioactive equilibrium between radon and its daughter products in French uranium mines. The decay products are collected on a filter and the decrease in α activity is observed by α spectrometry using a p–n junction barrier layer cell or with a photomultiplier for the total count. From the decay curves it is possible to calculate the concentrations of RaA, RaB, and RaC. Characteristics of the two methods are given along with a comparison of the results. (auth) (UK)

21699 ASSESSMENT OF ^{24}Na BODY BURDEN INDUCED BY NEUTRON EXPOSURE. Morsy, S. M.; Assaly, F. M.; Mohamed, H. O. (Atomic Energy Establishment, Cairo). Isotop. Radiat. Res.; 3: 9-17(Jun 1970).

An attempt was made to calibrate the Inshas whole-body counter for the assessment of the neutron induced ^{24}Na radioactivity in human bodies with the eventual purpose of determining the neutron dose received by human beings in case of neutron exposure accidents. The calibration was performed for the chair and arc geometries. Discrimination of ^{38}Cl was undertaken at different decay times after neutron exposure. Thresholds for detection in both geometries were determined. (auth)

21700 CONTROL OF INTERNAL CONTAMINATION BY MEANS OF A WHOLE-BODY COUNTER OF 4π GEOMETRY. Delwaide, Pierre A. (Univ., Liege). J. Belge Radiol.; 53: 405-21(Sep-Oct 1970). (In French).

The whole-body counter at the University of Liège, combines a high sensitivity and a low resolution. The conditions of its use for health physics purposes are discussed. Owing to a special calibration technique, it is possible to make relatively accurate measurements of ^{137}Cs in a population at large and to control persons exposed to contaminations by a single isotope known beforehand. The results of ^{137}Cs body burden were in agreement with the values obtained in other centers and showed the anticipated decrease since the end of the big nuclear bomb tests. In addition, the control of hospital staff has shown that minor but repeated ^{131}I contaminations are frequent; the other gamma radioelements seem to present fewer hazards of contamination in medical spheres. (auth)

21701 DEVELOPMENT OF CHROMOSOME STUDIES IN RELATION TO THE DOSIMETRY OF ACUTE AND CHRONIC RADIATION EXPOSURE. McLean, A. S. (United Kingdom Atomic Energy Authority, London). J. Belge Radiol.; 53: 387-96(Sep-Oct 1970).

The development of chromosomal studies in relation to the dosimetry of exposure to chronic and acute radiations are re-

ported. Biological dosimetry by counting the dicentric chromosomes may be used for acute exposure, whereas for low level chronic exposure, the chromosomal aberrations observed had no clinical significance. (auth)

21702 RADIOISOTOPE MAXIMUM PERMISSIBLE CONCENTRATION CALCULATIONS EMPLOYING AN IBM 360/65 COMPUTER. Smith, Harry Lincoln. College Station, Tex.; Texas A and M Univ. (1970). 419p. University Microfilms Order No. 70-16,761.

Thesis.

The International Committee on Radiological Protection (ICRP) Committee II Report of 1958 listed recommended Maximum Permissible Concentration (MPC) values for 240 radionuclides. Because of an increase in radioisotope research and uses since 1958 and because of the existence of approximately 1000 radionuclides, additional MPC values were needed. Furthermore, as research yielded newer physical and biological constants, a coherent calculational technique for efficient MPC evaluation became imperative. Based on the existing need for additional MPC values and the availability of new data on which to found MPC value calculation, a three-part computer calculational technique was developed. The computer program consists of a computer logic section written in FORTRAN language, a nine array physical data section, and a multivalued, mutually exclusive biological data section. Using an IBM 360/65 Computer, approximately 900 radionuclide MPC values were calculated. Agreement between the previously published ICRP Committee II MPC values and the new MPC values was generally close. (Diss. Abstr.)

21703 PULMONARY RETENTION OF ZIRCONIUM OXIDE (^{95}Nb) IN MAN AND BEAGLE DOGS. Waligora, Stanley J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys.; 20: 89-91(Jan 1971).

During routine whole-body counting of personnel it was found that a technician had a small but measurable burden of ^{95}Nb in the lung. It was decided that exposure had taken place 57 days earlier and thus only the long term phase of pulmonary retention could be measured. This mean biological half-time was calculated to be 224 days. The initial total deposition was estimated to be 90 nCi and the infinite integrated radiation dose to the lungs calculated to be 26 mrem. These data were compared with comparable observations in beagle dogs. It is suggested that these results indicate that Group 4b oxides, that includes ZrO_2, should be moved from Class (W) to Class (Y) as defined by ICRP in their report by the Task Group on Lung Dynamics. (UK)

21704 LOCATION OF RADIOACTIVE SOURCES USED IN THERAPY. THE USE OF A COMPUTER FOR CALCULATING THEIR POSITION. Rosenwald, J. C. (Institut Gustave Roussy, Villejuif, France). Ann. Phys. Biol. Med.; 4: 139-50(Jul-Sep 1970). (In French).

The distribution of doses corresponding to the interstitial or intracavitary implant of radioactive material can be accurately calculated only when the location of the material is accurately known. The method described allows the exact position, in terms of a coordinate system related to the patient, of any point or straight line source or point appearing on both radiographs to be determined. The calculation is easy to program on a small computer and can be used as the first stage of a complete dose distribution calculation with a large computer. (auth) (France)

21705 COMPUTER PROGRAM FOR THE DETERMINATION OF GAMMA EMITTER ACTIVITY IN BIOLOGICAL SAMPLES. Chorvat, D.; Kollar, J.; Trnovec, T.; Pleskova, A. Bratislav. Lek. Listy; 54: 173-84(Aug 1970). (In Czech).

The utilization of computers for formalization of radiobiological experiments is described. Program preparation for determination of activity of ^{144}Ce + ^{144}Pr as well as ^{59}Fe simultaneously occurring in biological samples is analyzed. A possibility of modification of a given computation for determining ^{59}Fe activity with increased background of ^{144}Ce + ^{144}Pr in biological sample is verified. (auth)

21706 IN VIVO DOSIMETRY. Tanaka, Yoshimasa (Tenri Hospital, Nara, Japan); Kuroda, Yasumasa; Takahashi, Masaji; Matsumiya, Akira; Ishida, Tetsuya. Rinsho Hoshasen; 15: 455-62(Jun 1970). (In Japanese).

For the purpose of obtaining accurate dose in tumor, actual measurement is far superior to the method utilizing the dose distribution curve obtained by measurements with phantoms. For in vivo ^{60}Co γ and x radiation dosimetry, the solid state dosimeter such as thermoluminescent and fluoroglass rod is useful, though ionization chambers, (Machlett-Alderson-Sievert) which are small and can be inserted into esophagus, vagina, etc., are also utilized. The above mentioned solid state dosimeters are superior to film dosimeter in the following points; they are more accurate and the measurements are reproducible; LiF is energy independent from 10 eV to several MeV; they are dose independent from several mR to 10^4R; they are direction independent; they are reusable; and measurement is easy and rapid. As to the advantage and disadvantage of thermoluminescence and glass rod, the latter is energy dependent below 300 KeV, though LiF is energy independent even in low energy. On the other hand, LiF is dose dependent above 800 R, showing superlinearity, though glass rod is dose independent up to 5,000 R. Thus, in vivo dosimetry often reveals the difference between the calculated and actually measured dose in tumor due to the deviation of patient's position, and is useful for improving irradiation technique. (Japan)

21707 CALCULATION OF PERCENTAGE DEPTH DOSES FOR IRREGULAR RADIATION FIELDS EMPLOYED IN RADIOTHERAPY. le Roux, P. L. M. (Groote Schuur Hospital, Cape Town. Univ. of Cape Town). S. Afr. Med. J.; 44: 990-3(29 Aug 1970).

A routine method is described for the calculation of percentage doses and isodose charts for rectangular fields of any shape and size in any plane inside or outside a tissue-equivalent medium irradiated with external beams of radiation for therapeutic purposes. It is particularly useful in cases where parts of rectangular fields are masked out to shield underlying organs. Scatter functions were determined for orthovoltage beams of x radiation and later extended to beams of γ ^{60}Co radiation. (auth)

21708 STUDY OF THE COMPUTER PROGRAM USED FOR DOSE CALCULATION IN GYNECOLOGIC CURIETHERAPY. Rosenwald, J. C.; Dutreix, Andree (Institut Gustave Roussy, Villejuif, France). J. Radiol., Electrol., Med. Nucl.; 51: 651-4 (Nov 1970) (In French)

In curietherapy, the dose delivered to a given point is a function of the geometrical parameters associated with the irradiation. The parameters intervene in a complex way and the calculation is laborious, however, the difficulty can be resolved by using a computer. In gynecological curietherapy the orthogonal radiographic method was chosen and only rectilinear and point sources considered. When using four sources the UNIVAC 117 computer required 45 seconds for printing a number table and 20 seconds to obtain the automatic trace of the isodoses in a plane. The same calculations may be made in a few seconds on CDC 6,600; this system allows the positions of the sources to be modified and furthermore can be used as a base for a complementary treatment using telecobaltherapy, for example. (France)

21709 CALCULATION OF DOSES IN GYNECOLOGICAL CURIETHERAPY WITH A COMPUTER. Chassagne, D.; Dutreix, A.; Attala, A. B.; Rosenwald, J. C.; Pierquin, B. (Institut Gustave Roussy, Villejuif, France). J. Radiol., Electrol., Med. Nucl.; 51: 647-50(Nov 1970). (In French).

Using a computer, a systematic study was made of optimum dose estimation in gynecologic curietherapy. In the cases studied, complementary use was made of curietherapy and transcutaneous radiotherapy; the anatomic regions considered were situated at the level of the uterine cervix, rectum, and pelvic lymph-node chain. The program used allowed the doses to be calculated in three mutually perpendicular planes. In each application six planes were studied as a routine. Although the method is still imperfect, useful conclusions can be drawn, for example, on the elimination of overdoses in transcutaneous radiotherapy, given either before or after the curietherapy. This research had led to an improvement in optimum dose estimation in gynecologic curietherapy. (France)

21710 MAXIMUM PERMISSIBLE INTAKES OF ^{35}S-L-METHIONINE AND ^{35}S-SODIUM SULPHATE DEDUCED FROM EXPERIMENTS ON RATS. Minski, Margaret; Vennart, J. (Radiological Protection Service, Belmont, Eng.). Health Phys.; 20: 1-9(Jan 1971).

The distribution of radioactive sulphur in various organs of the rat at different times after administration of ^{35}S-L-methionine and $Na_2{}^{35}SO_4$ is described and the results are extrapolated to man by making allowances for differences in organ masses and turnover times in the two species. It is suggested that the critical organ is bone marrow for both compounds. The results indicate that the value of the maximum permissible annual intake of ^{35}S-L-methionine is about 10^3 μCi, either by direct entry to blood or by ingestion and the value for $Na_2{}^{35}SO_4$ is about 10^4 μCi, also independent of the mode of entry. (auth) (UK)

21711 PHYSICAL AND RADIOBIOLOGICAL ASPECTS OF NEGATIVE PIONS WITH REFERENCE TO RADIOTHERAPY. Raju, M. R.; Richman, C. (Univ. of California, Berkeley. Univ. of Texas, Dallas). GANN Monogr.; No. 9, 105-21(1970). (UCRL-18806).

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The dose delivered by negative pions as they pass through a tissue-like medium increases slowly with depth, giving rise to a distinct maximum known as the Bragg peak near the end of the range, as do other heavily charged particles. In addition, when the negative pions come to rest, they are captured by the nuclei in the medium and produce stars consisting of many short-range, heavily ionizing fragments. These fragments enhance the dose as well as the biological effect at the Bragg-peak region, while the damage produced is less dependent on the oxygenation status of cells irradiated. The production of π mesons, their interaction with tissue, and the results of physical and radiobiological measurements of negative π mesons with reference to radiotherapy are discussed. Physical measurements of depth-dose distribution indicate that the dose at the peak region is two to three times higher than that at the entrance, and LET (linear energy transfer) measurements indicate that at the Bragg-peak region a significant portion of the dose is due to high-LET components. Radiobiological measurements at the peak of the depth-dose distribution gave RBE (relative biological effectiveness) values in the region of two to five, depending on the biological end point used. The OER (oxygen enhancement ratio) at the peak is found to be significantly low compared with low-LET radiations such as x rays and γ rays commonly used in radiotherapy. (40 references.) (auth)

21712 REPORT OF THE INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS (ICRU) TO THE INTERNATIONAL EXECUTIVE COMMITTEE ON THE XIIIth INTERNATIONAL CONGRESS OF RADIOLOGY, TOKYO, 1969. Ney, W. R. (International Commission on Radiation Units, Washington, D. C.). Health Phys.; 19: 825-30(Dec 1970).

Publications by ICRU previous to the period under review (prior to 1969), those published during the period 1965 to 69 (Report 11, Radiation Quantities and Units and Report 12, Certification of standardized radioactive sources) and those at present being prepared for publication, are listed. The establishment of the ICRU medal honoring the late L. H. Gray and the choice of the first recipient are reported. The relationship of ICRU with other international organizations is discussed and the organizations listed. The Commission finances are stated and the membership is given. The outlook for the future is reviewed. The distribution of ICRU reports 1927–1968 and ICRU materials published outside of the ICRU reports series are given in two appendices. (UK)

21713 ESTIMATION OF THE GAMMA-RAY DOSE FROM THE ATOMIC BOMB INDUCED RADIOACTIVITY IN HIROSHIMA AND NAGASAKI. Maruyama, Takashi (National Inst. of Radiological Sciences, Chiba, Japan). Hoshasen Kagaku; 13: 225-8 (Feb 1970). (In Japanese).

The gamma-ray dose from the radioactivity induced in soil and building materials by neutrons was estimated on the basis of experimental data. The chemical composition of the soil and building materials collected in Hiroshima and Nagasaki were determined by activation analysis. It was found that ^{24}Na and ^{56}Mn contributed mainly to the gamma-ray dose from the radioactivity induced in soil. The dose received by a person who entered the epicenter area in Hiroshima one hour after the bombing and remained there 8 hr would have been 25 rads. The accumulated gamma-ray dose from immediately after the explosion of A-bombs to infinity was about 80 rads at the epicenter in Hiroshima, and about 30 rads in Nagasaki. (Japan)

21714 SCATTER CORRECTIONS IN BOUNDED MEDIA FOR THE DOSES FROM INTERNALLY EMITTED GAMMA RAYS. Hubbard, L. B.; Williamson, F. S. (Argonne National Lab., Ill.). Phys. Med. Biol.; 16: 35-46(Jan 1971).

A method is presented for an approximate calculation of the contribution of multiple scattered photons to the dose of phantoms containing uniformly distributed internal emitters. The method is valid for phantoms with dimensions of the order of a photon mean free path or smaller. The technique is equally useful for average doses or point doses. For spheres and cylinders, the average and point doses can be found by applying simple algebra to existing data. For other geometries, the method is still valid, but require numerical calculation of some dose parameters. (auth) (UK)

21715 METHODS OF TECHNOLOGIC CONTROL OF THE CONTENT OF RADON IN WATER IN RADON LABORATORIES AND THERAPEUTIC BATHS. Andreev, S. V.; Gusaroz, I. I. Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 34: 166-70(Mar-Apr 1969). (In Russian).

An attempt is made to measure the radon content of water by the use of more modern instruments such as scintillation γ detectors equipped with photomultipliers. Methods of sampling the radon water for measurement are described. Two sizes of scintillation counters were employed: a large fixed installation with a NaI(Tl) crystal 40 × 40 cm, and a smaller portable unit with a smaller crystal. A standard radium source containing about one microcurie (0.001 mg Ra-226) was used to calibrate the equipment. Various corrections to obtain accurate radon measurements are indicated. With the use of this system of control it is possible to determine the radon content quickly and accurately, and to take measures to prevent radon losses in the preparation of radon water. (TTT)

21716 PERSONNEL DOSIMETRY OF IONIZING RADIATIONS. Leggett, W. J. Brit. J. Occup. Saf.; 8: 148-51(1969).

Various types of ionizing radiation are described and certain basic terms and units are defined. The requirements of radiation measuring instruments are enumerated and types of dosimeter in use are described, namely, film badge, quartz fibre dosimeter, thermoluminescent dosimeter (crystal and powder systems), personal pocket monitor, and radiation monitor. The advantages and disadvantages of each type are compared. (Occup. Safety and Health Abstr.)

21717 MEASUREMENT OF DOSE DISTRIBUTIONS OF HIGH ENERGY PHOTONS WITH PHOTOGRAPHIC EMULSIONS. Schneider, P. (Univ. of Saarlandes, Saarbruecken, Ger.). Stud. Biophys.; 23: 187-92(1970). (In German).

A film processing method with high reproducibility was developed for the measurement of dose distributions with photographic emulsions. A densitometer was constructed working on line with a digital computer. Dose distributions were measured with a film selected especially for high energy X-rays. (auth)

21718 CRITICALITY DOSIMETERS FOR ACTIVITY MEASUREMENTS. Eggermont, G.; Decraemer, W.; Segaert, O.; Jacobs, R. (Rijksuniversiteit, Ghent). J. Belge Radiol.; 53: 220-9 (May-Jun 1970). (In Dutch).

Methods are described to establish the γ doses, the fast neutron flux together with the incident and body-reflected thermal and intermediate neutron fluxes by means of the personal A.E.R.E. criticality dosemeter with incorporated $CaSO_4$–Mn thermoluminescence dosemeter. The results of tests and experiments are summarized, they led to a direct method for interpretation of the criticality dosemeter. (auth)

21719 $CaSO_4$–Mn DOSIMETRY IN DENTAL X-RAY DIAGNOSIS. Eggermont, G.; Masood, A.; Jacobs, R.; Segaert, O. (Rijksuniversiteit, Ghent). J. Belge Radiol.; 53: 212-19(May-Jun 1970).

Skin doses, thyroid doses, doses on eye lenses, and gonad doses were measured on phantom or patients with $CaSO_4$–Mn thermoluminescent dosemeters for most of the current radiographic techniques. Intercomparisons of calculated and measured doses were made. The dose reduction was investigated ensuring the elimination of leaks, employing added filtration, and using a beam collimating device. The doses could be reduced by a factor 10 to 40. (auth)

21720 FORM AND FUNCTION OF THE LYMPHOCYTE AS A RADIATION DOSIMETER AND AN INDICATOR OF IMMUNOSUPPRESSION. Barnes, C. A.; Ilbery, P. L. T.; Rickinson, A. B. (Univ. of Sydney). Med. J. Aust.; 369-72(13 Feb 1971).

Cytogenetic measurement of absorbed radiation dose, involving scoring of lymphocytic chromosome aberrations is described. Of seven recognizable aberrations, dicentric formations are considered easiest to score. It is anticipated that the advent of fixed time sampling will provide more information on correlation of chromosome damage with dose. A method involving calibration of radiation dose by measurement of in vitro lymphocyte replicating ability is discussed. It is thought that this method of testing proliferative response to a mitogen contributes to measurement of inherent immunological depression associated with some forms of cancer therapy. Correlation in balancing values between tumor palliation and lowered host resistance is hoped for. (Australia)

21721 PANORAMIX IN RADIOLOGICAL DENTAL DIAGNOSTICS. Jarzab, Grazyna. Czas. Stomatol.; 23: 1063-6(Sep 1970). (In Polish).

Testing of the Panoramix roentgenological apparatus showed that magnified panoramic films of the maxillae are a useful diagnostic aid for the dentist. They permit the dentist a rapid orientation in and evaluation of the anatomical details, particularly in the anterior part of the maxillae. The panoramic radiograms are easily made and they show on one film a whole maxilla or mandible while the radiation dose received is only slight. (auth)

21722 RESULTS OF MEASUREMENTS OF INDIVIDUAL DOSES IN PERSONS OCCUPATIONALLY EXPOSED TO X-

RADIATION IN POLAND IN 1969. Jankowski, Jerzy; Krych, Bozenna. Med. Pracy; 21: 385-93(1970). (In Polish).

The results of measurements of individual doses in 14,576 persons occupationally exposed to x rays in Poland are presented. It was found from the analysis of the distribution of yearly doses in 97.63% of persons examined that the yearly dose did not exceed 400 mR (1/12 of allowable yearly dose). Comparing the data for 1968, the number of persons in this group increased by 0.26%. In 15 persons the yearly dose exceeded the allowable level of 5 R. Fifty percent of all the persons that received doses exceeding the allowable level were laboratory assistants working with x-ray apparatus. They made up 21.1% of all the persons examined. In 1969, 108 cases exceeding quarterly doses were noted; 56 cases out of those were considered as artefacts on the basis of investigations conducted by sanitary officers. The excess of yearly and quarterly doses was usually due to the fact that a high dose was received during one month by particular persons. An improvement in work hygiene was observed in exposure conditions, resulting in the increase of persons whose yearly dose did not exceed 400 mR and in absolute and percentage decrease of number of exceeded quarterly doses. (auth)

Radiation Protection

Refer also to abstracts 21702, 21769, and 21894.

21723 RADIATION PROTECTION CONSIDERATIONS OF OVERHEAD FLUOROSCOPIC INSTALLATIONS. Jacobson, Ahren (Univ. of Louisville, Ky.). Health Phys.; 20: 55-8(Jan 1971).

Recently some manufactures of x-ray equipment in this country have copied a European trend for installation of diagnostic x-ray rooms with an overhead fluoroscopic arrangement. The obvious advantage for performing fluoroscopy in this manner is an economic one. Thus, one x-ray tube can be used for both radiographic exposures and fluoroscopic examinations. When operated remotely, radiation protection problems are minimal. However, in actual practice, some users of this equipment find it necessary to be situated near the patient during fluoroscopy. Data are presented to show the hazards associated with such use. Remedial efforts for achieving acceptable operation are described. The different back-scatter geometry that obtains in overhead fluoroscopy can explain the increased exposure levels to personnel versus those found in conventional fluoroscopy. (auth) (UK)

21724 SURVEY OF DENTAL X-RAY EQUIPMENT AND RADIOLOGICAL PRACTICES IN NASSAU COUNTY NEW YORK. Pentel, L. (New York Univ., N. Y.); Goren, A. D.; Shapiro, G.; (and others). Health Phys.; 20: 59-71(Jan 1971).

Representative dental x ray equipment in current clinical use was evaluated with respect to the half-value layer and intensity of the radiation emitted, timer accuracy and collimation. Radiological practices associated with this equipment were also studied to determine the influence of factors which contribute to patient exposure. The average exposure per film (753 mR) was found to be lower than that previously reported in similar studies, largely through the increasing use of high speed film. This is however, still markedly elevated above the minimum required for diagnostic image production. This is ascribed to the wide variations in equipment function observed; deviations from recommended darkroom methods; and the use of exhausted developers. Timer deficiencies noted in 80% of the equipment examined, further amplify the inability of the operator to accurately and repetitively obtain precise exposure intervals. The observations made in this study comprise a preliminary indication of the need for standards on dental radiation equipment and practices, which may be significant in curtailing the radiological burden now incurred in dental procedures. They also strongly reinforce the thesis that the informed use of ionizing radiation is a vital prerequisite to promoting the most appropriate use of x-rays in clinical application. (auth) (UK)

Safety Procedures

Refer also to abstracts 21476, 23207, 23210, and 23211.

21725 NASSAU COUNTY MICROWAVE OVEN STUDY, JUNE 1969–MARCH 1970. Mafrici, David; Bernstein, Sheldon V.; Miller, Charles E. (Nassau County Dept. of Health, Mineola, N. Y.). Radiol. Health Data Rep.; 11: 667-70(Dec 1970).

The Radiological Health Section of the Nassau County Department of Health conducted a survey of microwave ovens located in Nassau County, New York. A total of 166 ovens were surveyed between June 1969 and March 1970. It was found that 23 of the 166 ovens (14%) exceeded the industry's standard of 10 mW/cm^2 during normal operation. When the door was in the process of being opened, 69 of the 166 ovens (42%) exceeded the standard. The owners and the manufacturers of the ovens were notified of the results of the survey and recommendations were made for correction of deficiencies. (auth)

21726 RECOMMENDATIONS ON SAFETY ENGINEERING IN MASS LABELLING OF YOUNG FISHES WITH RADIOACTIVE ^{45}Ca THROUGH WATER. Bogoyavlenskaya, M. P.; Karzinkin, G. S. Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 69: No. 2, 76-8(1970). (In Russian).

Safety techniques during mass labeling young sturgeon with radioactive calcium include the following procedures: preparation of the basin for fish labeling, and protection against contamination by PK-4 film, filtration of radioactive water through a cation resin KU-1, and a special device for purification of the water. (R.V.J.)

21727 ON SAFETY ENGINEERING IN MASS LABELLING OF YOUNG STURGEONS WITH RADIOACTIVE CALCIUM. Bogoyavlenskaya, M. P. Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 69: No. 2, 70-5(1970). (In Russian).

Rules and regulations are given for safety techniques in mass labeling of fish with radioactive calcium. Polyamide film PK-4 for basin protection against radioactive contamination and cation exchange resin KU-1 for purification of water from ^{45}Ca used for mass fish labeling were recommended. A design is given of an industrial scale device for higher purification of water that is based on contact of water and cation resins. (R.V.J.)

Legal Aspects

21728 RESTUDY OF THE SYSTEM OF ATOMIC-ENERGY DAMAGE INDEMNIFICATION. Osawa, Wataru (Nippon Fire and Marine Insurance Co. Ltd., Tokyo). FAPIG (Tokyo); No. 57, 59-62(May 1970). (In Japanese).

The system in Japan of atomic-energy damages indemnification is made up of the two laws, i.e. "The Law on the Indemnities for Atomic-energy Damages" and "The Law Concerning the Compensation Contracts for Atomic-energy Damages Indemnity." Since the promulgation of the laws, nine years have already passed. With the advance in this field during the time, the Government is carrying out the restudy on the system of atomic-energy damages indemnification, for completion in the fall of 1970. After reviewing the existing system, the main items of restudy are described: the limit of obligations by enterprises; the rise in the amounts of compensation for indemnities; the limitation on claim of indemnifications; compensation of the third party; compensation for transportation media; injuries to the personnel; and nuclear-powered ships. (Japan)

21729 ATOMIC ENERGY AND RADIOACTIVE SUBSTANCES. THE RADIOACTIVE SUBSTANCES (ROAD TRANSPORT WORKERS) (GREAT BRITAIN) REGULATIONS 1970. STATUTORY INSTRUMENTS 1970. No. 1827. London; Her Majesty's Stationery Office (1970). 15p. 2s. 6d.

Comprising sections dealing with the following: Interpretation; application; general prohibitions and requirements; notification of licensing authority; contents of notice; approval of schemes of work; approved schemes, operation; tests of personal exposure to radiation; classified workers; radiation dose records for classified workers; initial medical examination for classified workers; medical supervision of classified workers; medical examinations of classified workers; recommendations by appointed doctor; facilities for appointed doctor; health register; transfer records; form and preservation of records; exemptions in relation to workers who are otherwise protected; self-employed persons. (UK)

21730 SAFETY MEASURES ASSOCIATED WITH THE DEVELOPMENT OF ATOMIC ENERGY. SAFETY IN TRANSPORT OF SPENT FUELS. Aoki, Shigebumi (Tokyo Inst. of Tech.). Genshiryoku Kogyo; 16: No. 4, 125-8(Apr 1970). (In Japanese).

IAEA's Regulations are about to be revised with respect to radioactivity restrictions for the transported materials, permissible leaks at accidents, and exterior radiation doses during transport. Revision of Japan's regulations in accord with IAEA, participation in the international meetings, and development of transport containers are also considered. (Japan)

21731 SITUATION IN FISCAL 1969 CONCERNING THE ENFORCEMENT OF THE RADIATION INJURY PREVENTION LAW. Kagaku Gijutsucho Geppo; No. 170, 9-10(Oct 1970). (In Japanese).

Concerning the enforcement of the law for the prevention of radiation injury, the situation in fiscal 1969 or at the end of the

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fiscal year is reported, including the use, sale and disposal of radioactive isotopes RIs, the future prospect of radioactive isotope utilization, and the inspection of facilities. The number of institutions, using radioactive isotopes included 686 private enterprises, and 588 medical, 366 research, and 152 educational institutions. The increase rate of utilization is especially remarkable in the private enterprises. On the whole, the increase has been linear for the past ten years, and was especially marked in fiscal 1969. The future increase will be largest for private enterprises, followed by medical and educational institutions, in order. Finally, the inspections carried out in the past years are summarized. The number of persons permitted to handle radioactive isotopes was about 7000, as of the end of fiscal 1969. (Japan)

21732 REGULATION AND SAFETY. Martin, H. (Centre d'Etudes de Prevention, Paris). Tech. Mod.; 62: 449-52(Oct 1970). (In French).

The basic ideas concerning radioprotection are briefly discussed (maximum doses, maximum quantities, maximum permissible concentrations). The problem of the protection of workers and the transport and storage of radioactive substances is examined. The rules concerning the classification of establishments are given. (France)

21733 ATOMIC ENERGY AND RADIOACTIVE SUBSTANCES. THE RADIOACTIVE SUBSTANCES (CARRIAGE BY ROAD) (GREAT BRITAIN) REGULATIONS 1970. STATUTORY INSTRUMENTS 1970. No. 1826. London; Her Majesty's Stationery Office (1970). 19p. 2s. 6d.

Comprising sections dealing with the following; interpretation; knowledge of radioactivity; application; general prohibitions; general obligation affecting consignors, carriers, and drivers; particular prohibitions and obligations affecting consignors; particular prohibitions and obligations affecting carriers; particular obligations and prohibitions affecting drivers; exemption for certain packages and substances; partial exemption for certain vehicles and packages. (UK)

21734 NEW RADIOLOGICAL HEALTH LAW FOR CANADA. THE RADIATION-EMITTING DEVICES ACT, 1969. Booth, A. H. (Dept. of National Health and Welfare, Ottawa). Can. J. Public Health; 61: 430-2(Sep-Oct 1970).

New legislation designated as Bill S-14 has recently been introduced to cover a wide range of devices that are used primarily for industrial, medical and scientific applications. The need for control in the design and sale of any apparatus emitting electromagnetic radiations is recognized. It will enable the government to establish minimum safety standards with respect to the design and construction of radiation devices of various kinds as a supplement to the work of the Atomic Energy Control Board. The radiation-emitting devices covered include X-ray machines, microwave ovens, laser generators and electronic equipment which emit radiation as an unwanted by-product of their operation. (Canada)

21735 NEW HAMPSHIRE RULES AND REGULATIONS FOR THE CONTROL OF IONIZING RADIATION. At. Energy Law Rep.; No. 738, 31-64(8 Aug 1969).

Regulations of the State of New Hampshire to assure the protection of personnel, patients, and the general public against exposure to excessive doses of ionizing radiation are summarized. (C.H.)

Medicine

Refer also to abstracts 21675 and 21676.

Protective Substances

Refer also to abstracts 21569, 21594, 21661, 21665, 21780, 21808, 21821, and 21954.

21736 EFFECT OF DIETHYLPYROCARBONATE (DEPC) ON THE RADIOSENSITIVITY OF MOLD SPORES. Hattori, Yukihiko (Inst. of Physical and Chemical Research, Yamato, Japan). Sci. Pap. Inst. Phys. Chem. Res. (Jap.); 64: No. 3, 90-7(Sep 1970). (In French).

In the course of studies on the pasteurization of fruit juice by irradiation, the effect of diethylpyrocarbonate (DEPC) on the radiosensitivity of mold spores was examined. DEPC showed a sporicidal activity on spores of Rhinocladiella sp. and Penicillium terrestre at concentration of 10^{-4} M. Spores of Rhinocladiella sp. are sensitized in the presence of DEPC (2 to 8 10^{-4} M) in apple juice as well as in phosphate buffer at γ-irradiation. Spores of Penicillium terrestre are not sensitized under the same conditions, though they are almost equally sensitive to the sporicidal activity of DEPC as spores of Rhinocladiella sp. The results suggest that there are large differences among the effects of DEPC on the radiosensitivity of mold spores, and that the antifungal activity is not directly related to the sensitizing activity. (auth) (Japan)

21737 ANTIBODY FORMATION IN IRRADIATED RATS DEPENDING ON THE DOSE OF IONIZING RADIATION AND OF THE RADIOPROTECTION APPLIED. Nedyalkova, M.; Dimitrov, L. (Research Inst. of Haemotology and Blood Transfusion, Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 1317-20(1970).

Following administration of 400 to 800 R of γ and x radiation to rats, intraperitoneal injections of MEA, AET, and serotonin and mixtures of the three compounds were given. Tables are presented to show the effects of the radioprotective agents on the number of hemolysin-producing cells, serum hemolysins, and serum agglutinins in irradiated rats. The rats were immunized with sheep erythrocytes. It was shown that immunity to sheep erythrocytes was reduced by radiation. Data were also obtained on the effects of radioprotective agents on numbers of lymphocytes and polymorphonuclear leukocytes in irradiated rats. (H.L.W.)

21738 APPLICATION OF METAL FERROCYANIDE-ANION EXCHANGE RESIN TO THE ENHANCEMENT OF ELIMINATION OF ^{137}Cs FROM HUMAN BODY. Iinuma, T. A.; Izawa, M.; Watari, K.; (and others) (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 20: 11-21(Jan 1971).

In order to accelerate the elimination of internally deposited ^{137}Cs from the human body, we noticed the effectiveness of ferrocyanides of transition metals used for concentrating radiocesium from fission product mixtures. Prussian blue which is an iron ferrocyanide powder, has been employed in eliminating ^{137}Cs from rat and man. (UK)

21739 LONG-TERM EFFECTS OF S-(2-AMINOETHYL)-ISOTHIOUREAU-Br-HBr ADMINISTERED TO MICE. Leonard, A.; Mattelin, G. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Compt. Rend. Soc. Biol.; 164: 907-9(1 Dec 1970). (In French).

The effect of an S-(2-aminoethyl)-isothiourea (AET) injection on the life span was studied in male and female mice of strain BALB/c. While the females always live less long than the males because of a high mammary tumour rate, no statistically valid difference was found between reference and treated animals whatever their sex. (France)

21740 ROLE OF ENDOGENEOUS HISTAMINE IN THE RADIORESISTANCE OF RADIOPROTECTORS. Goncharenko, E. N.; Kudryshov, Yu. B.; Briedis, I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 191: 948-50(1 Apr 1970). (In Russian).

White rats (120 to 150 g body weight) were given aqueous solutions of radioprotective substances intraperitoneally 10 to 15 minutes before a whole body x-ray irradiation at a dose of 400 to 1400 rads. The content of free and total histamine was determined in the skin, stomach, liver and kidneys 10 to 20 minutes after administration of the radioprotective substances. Serin and a 0.85% solution of NaCl served as controls. The radioprotective substances were aminoethylisothiuronine (AET), beta-mercaptoethylamine (MEA), cysteine and serotonin. The factor to reduce the radiation dose causing 50% mortality over 30 days was taken as a criterion of the protective effect of the material given to the animal. The decrease in oxidation-reduction potential measured subcutaneously with a Pt electrode was taken as another criterion. The more effective the radioprotective agent as measured by the above criteria, the greater the amount of free and total histamine found in the tissues of the irradiated animals. Thus, the organism is able to accumulate an endogenous radioprotector (histamine in this case) in its tissues, and increase its radioresistance. (TTT)

21741 PROTIVOLUCHEVAYA ZASHCHITA ORGANIZMA. (Radiation Protection of Organisms). Yarmonenko, S. P. Moscow; Atomizdat (1969). 264p.

Information on biological protection against ionizing radiation is summarized from first-hand experimental results and from the current literature. Using cytokaryological methods, the protective effects of bone marrow against radiation insult were analyzed, providing substantial evidence that the mechanism underlying biological radiation protection involves the reduction of the initial radiation damage in critical systems of the organism. The possibility of modifying the effects of different types of ionizing radiation (x rays, γ rays, and high-energy protons) is considered in detail for single, fractionated, and chronic exposures. An attempt was made to analyze the relation between the extent of radiation dam-

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age and the protection of the genetic apparatus in somatic cells by altering the dose rate, and to evaluate the role of this phenomenon in acute and latent radiation effects. The book emphasizes practical aspects in discussing the various problems (application of radioprotective measures to human situations, hygienic principles for standardization of radiation quality). The wide range of questions dealt with, their urgency, and the critical consideration given to a large amount of material, from both first-hand investigations and current literature citations, suit the book first of all to specialists interested in the biological effects of radiation and to university students in advanced courses. However, the consistency in the presentation of material, the logical relation between chapters, and the understandable style of the presentation, also make the book interesting to a wide range of readers lacking special training. (tr-auth)

21742 PROBLEM OF PREVENTION OF RADIATION DAMAGE IN SPACE FLIGHTS. Rogozkin, V. D.; Davydova, S. A.; Tikhomirova, M. V.; Chertkov, K. S. Kosm. Biol. Med.; 4: No. 5, 13-17(Sep-Oct 1970). (In Russian).

The effectiveness of two types of radioprotectants—chemical and biological—was studied using short- and longterm irradiation of animals. Biological radioprotectants, such as amino acids, bacterial polysaccharides, hormones, and vitamins gave a 16 to 25% increase in survival time for mice after prolonged irradiation. It was concluded that biological radioprotectants may be well used in space flights. (auth)

21743 PROTECTION OF SPACECREWS FROM COSMIC RADIATION BY RADIOPROTECTANTS. Saksonov, P. P.; Antinov, V. V.; Davydov, B. I.; Dobrov, N. N. Kosm. Biol. Med.; 4: No. 5, 17-19(Sep-Oct 1970). (In Russian).

General approaches to the radiation protection of space crews with the aid of various drugs are discussed. An attempt was made to extrapolate the experimental data obtained on animals to humans. The validity of the extrapolation was confirmed by observations accumulated in the clinical use of radioprotectants during x-ray treatment. (auth)

21744 RAPID METHODS FOR THE INITIAL SELECTION AND STUDY OF THE PROPERTIES OF CHEMICAL MEANS OF PROTECTION AGAINST RADIATION INJURY. Kudryashov, Yu. B. Vestn. Mosk. Univ., Ser. VI, Biol. Pochvoved; 25: No. 2, 51-70(1970). (In Russian).

Although many radioprotective materials are known, they are selected on an empirical basis because of lack of knowledge of the protective mechanism. The author's earlier study on the radiomimetic action of lipids served as the starting point to the development of models for evaluating radioprotective agents. The studies, carried out during the last ten years, are summarized, reviewing the action of aminoalkyl thiols, aminoalkyl disulfides, aminoalkyl isothiuronium (Bunte's salts and thiazolides), free-radical reaction inhibitors, and other biologically active substances. Each group was represented by 3 substances exhibiting different radioprotective action; the dose reaction factor served as the main criterion for evaluation. The erythrocyte radiomimetic model was found convenient for the study of the radioprotective effect, assuming that their toxicity does not mask their potential radioprotective properties. The Bunte salts and related substances were examined on the basis of the hydrolytic stability of thiazolidins but no direct correlation could be examined between that property and their protective action. (TTT)

21745 BIOCHEMICAL MECHANISMS IMPLICATED IN THE SENSITIZATION OF LIVING ORGANISMS BY CHEMICAL AGENTS TO THE ACTION OF RADIATION AND CYTOSTATICS. I. THE EFFECT OF IRRADIATION OF RATS INJECTED WITH P-HYDROXYMERCURIBENZOIC ACID ON THE CHROMATOGRAPHIC PROFILE OF DNA. Furnica, Maria; Spiridon, M.; Ganea, Adriana (Institut Oncologique, Bucharest). Rev. Roum. Biochim.; 7: 265-73(1970). (In French).

P-hydroxymercuribenzoic acid sensitizes rats following 800 R irradiation, diminishing considerably the survival time. DNA extracted three days later from the liver of radiosensitized rats shows a different fractionation on an albumin methylkieselguhr column, as well as chromatographic profile, from the DNA extracted from untreated irradiated rats. The modifications do not appear immediately after the irradiation and seem to be bound to the repair phase of the radiolesions of the DNA. (tr-auth)

21746 HAS O-(β-HYDROXYETHYL)-RUTOSIDE A PROTECTIVE EFFECT IN IRRADIATED AND NON-IRRADIATED TISSUE? MODELS: PUNCH-TEST ON RABBIT'S EAR BY HEITE AND TEARING-TEST ON THE ABDOMINAL SKIN OF THE GUINEA PIG. Klemm, J. (Univ., Munich). Arzneim.-Forsch.; 20: 817-21 (Jun 1970). (In German).

On a total of 142 rabbits and 165 guinea pigs in 6 test groups subdivided into 25 experimental series the pharmacological effects of O-(β-hydroxyethyl)rutoside (RH : Venoruton®) and of its components tri- and tetra-HR on the healing rate of the punch holes in the rabbit ear and on the tensile strength of lesions in the ventral skin of guinea pigs were tested. Some of the animals were subjected to irradiation of the ear region with 2000 re⁻. In the tearing test, only during the fibroblast phase (second to fourth day) wound healing was improved. The punch-test demonstrated improved wound healing, mainly towards the end of the healing period (12th to 24th day). Application of 45 mg HR/kg animal i.m. clearly protected against irradiation effects. This result obtained in a double-blind trial was of high statistical significance. The following testing parameters were used: mean healing rate, surface growth rate and decrease in punch hole diameter. (auth)

Radiation Sickness and Injuries

Refer also to abstract 21908.

21747 RELATIONSHIP BETWEEN OXIDATIVE PHOSPHORYLATION IN THE MITOCHONDRIA OF LIVER CELLS IN RATS IRRADIATED WITH 800 r AND THE TIME OF HOMOTRANSPLANTATION OF BONE MARROW. Malovichko, I. I.; Shamray, A. E. (Kiev Medical Inst.). Vrach. Delo; No. 4, 148-9(1970). (In Russian).

Experiments confirmed the view of those investigators who believe that homotransplantation of bone marrow 24 hr after irradiation produces a better therapeutic effect than when the procedure is carried out at later times. Oxidative phosphorylation of mitochondria, a process that maintains the energy balance of the cell, was used as an indicator of the effectiveness of the transplants. Studies on white rats given bone marrow transplants 24 hr, 3 and 6 days after irradiation showed that respiration and phosphorylation in liver cell mitochondria were more intense 24 hr after irradiation than at either of the other two periods. (JPRS)

21748 SURGICAL TREATMENT OF WOUNDS IN COMPOUND INJURIES. Duknic, Mihailo; Piscevic, Stanislav; Bervar, Marijan; Atanasijevic, Todor. Vojnosanit. Pregl.; 26: 438-42(Sep 1969). (In Slovene).

Compound injuries sustained during exposure to ionizing radiation were discussed, defining the concept as a combination of radiation sickness, mechanical wounds, burns, and additional injuries caused by chemical or bacteriological agents. In these cases certain effects were observed that were not a simple summation of the individual factors. The symptoms or radiation sickness were described. This was followed by an indication of the effects of chemical poisoning. The massive nature of these injuries requires a detailed knowledge of the pathogenesis, prognosis and methods of treatment by the physician. The nature of compound injuries makes it necessary to treat mechanical injuries during the latent period of the radiation injury, before the clinical manifestation of the acute radioactive disease. The danger of contamination during the acute period is not as high as it has been believed; treatment of wounds should not present a problem, as long as the basic protective measures have been used. Care should be taken to reduce the general toxic reaction before surgical interference. (TTT)

21749 FUNKTSIONAL'NYE MEKHANIZMY RAZVITIYA RADIOBIOLOGICHESKIKH EFFEKTOV. (Functional Mechanisms of Radiological Effect Development). Kovalev, I. F. Moscow: Atomizdat (1969). 312p.

A brief critical survey of the main hypotheses and concepts relating to the mechanisms underlying the biological effects of ionizing radiations is presented. On the basis of personal observation and review of the available literature concerning the rules governing the development and manifestation of the final biological effects of ionizing radiation, the author has formulated and presents here an original concept regarding the mechanisms functioning in the development of radiobiological effects. The originality, and the distinguishing characteristic, of this concept lies in the fact that it encompasses all of the basic manifestations of radiobiological effects. Included in this one concept are the difficult questions of a theoretical nature relating to the effects of the biological action of radiation such as: the carcinogenic as well as the therapeutic effects on tumor growth; the suppression of the processes of differentiation; the acceleration of the aging process; the suppression of immune processes; and the antiphlogistic effects. An original interpretation of the processes of carcinogenesis and of the mechanisms of the antitumorigenic effects of the basic therapeutic agents (radiation, hormones, and pharmaceuticals) is given. Based on an analysis of the general biological mechanisms of aging, a theory regarding the restoration of the effects of aging is presented. This theory, based on the complete autoregeneration

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of structures, provides an explanation for the apparent contradiction between the second law of thermodynamics and the observed progressive development of living structures. A separate chapter is devoted to a survey of the main ideas concerning repair mechanisms in irradiated tissues and an analysis of the conditions that initiate the repair processes for different types of acute radiation injuries. The book will be of interest to biologists, radiobiologists, oncologists, gerontologists, geriatrists, philosopher-biologists, and specialists in related disciplines. (tr-auth)

Radiodiagnosis

Refer also to abstracts 20961, 21237, 21382, 21384, 21387, 21402, 21412, 21413, 21415, 21538, 21687, 21719, 21721, 21723, 21905, and 21913.

21750 (ANL-7760(Pt.2), pp 63-94) QUANTITATIVE CHARACTERIZATION OF BONE. A COMPUTER ANALYSIS OF MICRORADIOGRAPHS. Lloyd, Elizabeth; Hodges, Donald (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969–June 1970.

A series of morphological measurements were made on bone samples by means of an automatic scanning device for microradiographs which characterizes bone mineral. The results obtained from a large number of measurements of various skeletal sites in man, dog, and mouse bones are reported. Parameters measured include marrow cavity size, mineral content, trabecular thickness, and volume. The application of these measurements to a number of problems in skeletal metabolism is cited. (C.H.)

21751 NEUTRON RADIOGRAPHY OF OSSEOUS TUMORS. Boyne, Philip J. (Univ. of California, Los Angeles); Whittemore, William L. Oral Surg., Oral Med., Oral Pathol.; 31: 152-6(Feb 1971).

Neutron radiography may provide a significant diagnostic tool for use in research and surgical pathology as an adjunct to the usual microscopic methods of tissue examination. The use of neutron radiography in the examination of human osseous surgical specimens for the purpose of delineating the extent of soft-tissue tumor-extension within bone is reported. The neutron source for this study was provided by a nuclear reactor. The thermal neutrons were appropriately collimated to form a beam with limited angular divergence (~1/100 radians). After the neutron beam penetrated the specimens, a 0.001 inch gadolinium screen was used to convert the neutrons to 70 keV electrons, which created the photographic image on the x-ray film. Standard techniques for developing and processing the x-ray film were used. (C.H.)

21752 POTASSIUM IODIDE BLOCK OF CHOROID PLEXUS VISUALIZATION IN TECHNETIUM BRAIN SCANS. Fayen, William J. (Lakewood Hospital, Ohio). J. Nucl. Med.; 12: 98 (Feb 1971).

Visualization of the choroid plexus in ^{99m}Tc-pertechnetate brain scans may occasionally interfere with scan interpretation. Premedication with perchlorate will block choroid plexus uptake of pertechnetate, but because perchlorate is not FDA-approved for general use, an acceptable substitute was sought. Potassium iodide has given uniformly good results. (C.H.)

21753 DIAGNOSIS AND DIFFERENTIATION OF CONSTITUTIONAL HYPERBILIRUBINEMIAS USING SEQUENTIAL SCANNING WITH ^{131}I-BSP (MONOIODIDE). Lio, Masahiro (Tokyo Univ.); Yamada, Hideo; Kameda, Haruo; (and others). J. Nucl. Med.; 12: 95-7(Feb 1971).

Extensive reports have been published about Dubin-Johnson and Rotor diseases since their discovery along with Gilbert disease and Criegler-Najjar syndrome. Both Dubin-Johnson and Rotor types were regarded as constitutional hyperbilirubinemias in the narrow sense. The two types are considered closely related as far as bilirubin metabolism is concerned. To clarify the mechanism and to differentiate these two disorders, ^{131}I-BSP (bromosulfophthalein) sequential scanning used on two patients with Dubin-Johnson syndrome, one patient with Rotor type, and one patient with Gilbert disease among 33 cases of constitutional hyperbilirubinemia. In the patient with Dubin-Johnson syndrome, ^{131}I-BSP showed no disturbance of hepatic uptake but notable disturbance of the mechanism of ^{131}I-BSP excretion into the bile canaliculi. In the patient with Rotor type, marked disturbance of hepatic uptake was seen with ^{131}I-BSP, but no excretion disturbance is noted. The patient with Gilbert disease showed neither uptake disturbance nor excretion disturbance with ^{131}I-BSP. Therefore, as far as cases studied are concerned, Dubin-Johnson syndrome and Rotor type are regarded as different disorders based on different pathophysiological mechanisms. Unlike ^{131}I-BSP, ^{131}I-rose bengal does not clearly differentiate Dubin-Johnson and Rotor-type disorders during scanning. (auth)

21754 PRELIMINARY IMAGING STUDIES WITH A LARGE CRYSTAL SCINTILLATION CAMERA. Hayes, Michael (Univ. of California, Torrance). J. Nucl. Med.; 12: 93-4(Feb 1971).

The large-crystal scintillation camera achieves a 11½ in. useable field size and is able to resolve two lines two cm apart at four in. on a Kahehi line source phantom without introducing significant image distortion. In an imaging speed determination, 200,000 counts were attained in 0.74 min with one mCi of ^{99m}Tc and in 2.6 min with one mCi of ^{113m}In. By comparison, a divergent collimator system provides a larger field size, closely similar resolution, but slower imaging speed and mild to moderate image distortion. (auth)

21755 TWO SEVERE REACTIONS FOLLOWING A PULMONARY SCAN IN A PATIENT WITH IDIOPATHIC PULMONARY HAEMOSIDEROSIS. Bliek, A. J.; Bachynski, J. E. (Univ. of Alberta Edmonton). J. Nucl. Med.; 12: 90-2(Feb 1971).

Adverse reactions following the infusion of ^{131}I-human serum albumin macroaggregates are rare, and few have been reported. A 59-year-old woman with idiopathic pulmonary hemosiderosis demonstrated two different types of reactions following a lung scan which were believed to be caused by the associated administration of Lugol's solution. (auth)

21756 ^{113m}In SCANNING FOR VISUALIZING AND EVALUATING GIANT INTRACRANIAL ANEURYSM POST-OPERATIVELY. Lubin, E.; Dujovny, M.; Israeli, J.; Askenasy, H.; Lewitus, Z. (Tel Aviv Univ., Petah Tiqua, Israel). J. Nucl. Med.; 12: 88-9 (Feb 1971).

Indium-113m is a broad-spectrum scanning agent. When injected intravenously at pH 1.7, it binds to serum transferrin and serves as an excellent blood-pool label. The use of labeled ^{113m}In-transferrin for visualizing giant intracranial aneurysms in vivo and, more specifically, for evaluating the result of treatment after common carotid ligation is described. The persistence, reduction, or disappearance of the aneurysmal blood pool can be determined by this nontraumatic scanning method. (C.H.)

21757 IMAGE ENHANCEMENT OF RADIONUCLIDE SCANS BY OPTICAL SPATIAL FILTERING. Cykowski, C. B.; Kirch, D. L.; Polhemus, C. E.; Brown, D. W. (Martin Marietta Corp., Denver. Univ. of Colorado, Denver. Denver Veterans Administration Hospital). J. Nucl. Med.; 12: 85-7(Feb 1971).

The resolution of photoscan images from radionuclide scanning devices can be improved by using various data processing methods. The recent availability of an efficient algorithm for computing the fast Fourier transform (FFT) has made possible computerized investigation of linear filtering techniques in the frequency domain. A filter was designed that appears to improve scan image quality. This filter combines the inverse of the scanner modulation transfer function (MTF) with another function which maximizes the signal-to-noise ratio while maintaining ripple distortion of the processed scan image below the level of visual perceptibility. A method of constructing a variable amplitude absorption filter which has acceptable ripple properties was used. A one-dimensional plot of the filter characteristic is shown as a function of frequency. The central portion of the filter characteristic is an exponential function approximately defined by the inverse modulation transfer function of the scanning system. This exponential extends out to the spatial frequency which roughly corresponds to the resolution limit of the scanning device. The function is then terminated by a polynomial which limits the amount of high frequency noise appearing in the final processed scan. The optical filter was constructed by imaging a disk (Fig. 1A) onto a Kodak 649-F spectroscopic plate with a 20-power microscope objective. When the disk was rotating at several revolutions per second (Fig. 1B), the ratio of the black portion to the white portion of any circumference had the desired filter characteristic. After the exposed plate was developed, a microdensitometer plot was made to verify that the amplitude transmittance of the optical filter was correct. The mathematical basis and technical details of optical spatial filtering are reviewed. The clinical usefulness of such processing was demonstrated using the scan of a patient with metastasis of the liver. A 35-mm reduction of this scan was used as the input to the optical system. (C.H.)

21758 SECTION IMAGING BY COMPUTER CALCULATION. Muehlehner, G. (Nuclear-Chicago Corp., Des Plaines, Ill.); Wetzel, R. A. J. Nucl. Med.; 12: 76-84(Feb 1971).

A radioisotope method was developed by which section views of the brain are obtained. From a set of eight digitized scintiphotos, which includes the standard anterior, posterior, and lateral views, section views are calculated on an IBM 360/30 computer in a plane

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at right angles to the scintiphotos. The method has been evaluated clinically and was found to give a good representation of the actual distribution. Equipment to perform this procedure is becoming available in a growing number of hospitals; access to a large computer is required. Patient positioning is achieved using a modified rotatable chair. The technique requires at the moment, a patient who can cooperate at least minimally, and who is able to sustain the sitting position. As part of a routine brain scan study, the data may be obtained with only a few minutes of extra time on the γ camera. Although six to eight section views cover the regions of interest within the confines of the cranial cavity, in fact 20 to 40 section views may be calculated. The section views show high contrast and clearly display the low-level concentration characteristic of normal cerebral tissue compared to surrounding structures in which higher levels of activity produce a greater concentration. (auth)

21759 CHORIOCARCINOMA SCANNING USING RADIOLABELED ANTIBODY TO CHORIONIC GONADOTROPHIN. Quinones, Jose; Mizejewski, Gerald; Beierwaltes, William H. (Univ. of Michigan, Ann Arbor). J. Nucl. Med.; 12: 69-75(Feb 1971).

Considerable work has been done in producing antibodies to substances in neoplasms, giving the radiolabeled antibody intravenously and following the distribution of the antibody in vivo by various isotope detection methods. Human chorionic gonadotropic hormone (HCG) is an antigenic hormone that is relatively unique in a choriocarcinoma in a male. In this sense, it is a cancer specific antigen. Results are reported from scanning studies on Syrian hamsters, with human choriocarcinomas transplanted to their cheek pouches following administration of ^{125}I-labeled immunoglobulin G (IgG) from rabbits immunized with human chorionic gonadotropic hormone (HCG). The tumor was visualized when whole-body scans were performed during the following four days. (C.H.)

21760 CEREBROSPINAL FLUID CIRCULATION FOLLOWING SUBARACHNOID HEMORRHAGE. Rudd, Thomas G.; O'Neal, John T.; Nelp, Wil B. (Univ. of Washington, Seattle). J. Nucl. Med.; 12: 61-3(Feb 1971).

Radioisotope cisternograms using ^{131}I-labeled human serum albumin were performed on nine patients suspected of having communicating hydrocephalus following subarachnoid hemorrhage. All patients showed uniformly abnormal CSF flow, the main features being accumulation and persistence of IHSA in the enlarged ventricles, decreased migration of IHSA over the cerebral hemispheres, and late accumulation of IHSA in the area of the operative site. Despite the similar appearance of the cisternograms, the clinical courses were quite variable; four patients developed progressive neurologic signs and symptoms which were relieved by ventriculoatrial shunt while the remaining five patients improved spontaneously. Repeat cisternography performed on two of the latter patients showed a persistently abnormal pattern even though they had made an excellent recovery. Cisternography is a sensitive means of delineating abnormal CSF circulation; however, it does not differentiate compensated from decompensated communicating hydrocephalus. (auth)

21761 ^{99m}Tc-PERTECHNETATE FOR MEASURING THYROID SUPPRESSIBILITY. Shimmins, J.; Alexander, W. D.; McLarty, D. G.; Robertson, J. W. K.; Sloane, Diane J. P. (Western Regional Hospital Board, Glasgow. Gardiner Inst., Glasgow). J. Nucl. Med.; 12: 51-4(Feb 1971).

The suppression of the 20-min ^{132}I thyroid uptake has been used previously in the control of the treatment of thyrotoxicosis by antithyroid drugs. In this paper the use of the suppression of the 20-min ^{99m}Tc thyroid uptake in place of the 20-min ^{132}I uptake has been investigated. Owing to the organification of ^{132}I in the thyroid, doses of carbimazole in the range of 20 to 40 mg/day immediately reduce the 20-min ^{132}I uptake by an average of 20/100 because ^{99m}Tc is not organified in the thyroid. The 50/100 suppression of the 20 min ^{132}I uptake equals 50/80 suppression of the 20-min ^{99m}Tc uptake. Using these different criteria of the suppression of the 20-min ^{99m}Tc uptake, comparable results are obtained to the suppression of the 20-min ^{132}I thyroid uptake. (auth)

21762 MEASUREMENT OF BONE MINERAL IN VIVO BY PHOTON BEAM SCANNING. West, R. R.; Reed, G. W. (Univ. of Leeds, Eng.). Brit. J. Radiol.; 43: 886-93(Dec 1970).

An apparatus is described which measures the transmission of a beam of 60 keV γ radiation from ^{241}Am as it is scanned across a selected site in a patient. The transmitted count-rate is either displayed logarithmically for visual inspection of bone thickness profiles or collected on paper tape for analysis by computer. Various parameters to describe bone density are defined and discussed with particular reference to studies of the femur. The primary bone index derived from a scan represents a mass of bone per unit length; it is particularly useful in serial measurements and has a reproducibility of about 2%. For inter-patient comparisons an effective bone density (defined as bone index + cross-sectional area) is preferred; it shows a coefficient of variation of about 3%. The accuracy and reproducibility of these and other related parameters are discussed. The method enables account to be taken of variations in the soft tissue attenuation consequent upon variability in the muscle/fat ratio. Some clinical applications are briefly noted. (auth) (UK)

21763 AUSTRIAN SOCIETY FOR UROLOGY, SWISS SOCIETY FOR UROLOGY. JOINT MEETING IN BREGENZ, AUSTRIA, OCTOBER 3 AND 4, 1969. Helv. Chir. Acta; 37: 371-546(Aug 1970). (In German and French). (CONF-691053).

Thirty three papers are presented; separate abstracts were prepared for two. The remaining papers deal with surgical procedures in urology. (H.B.G.)

For abstracts of individual papers see: 21764 and 21765.

21764 GAMMA SCINTILLATION CAMERA IN UROLOGY. Erd, W. (Medizinische Univ., Vienna); Gasser, G.; Hoefer, R.; Niedoba, H. Helv. Chir. Acta; 37: 435-42(Aug 1970). (In German).

From Joint Meeting in Austrian and Swiss Society for Urology, Bregenz, Austria. See CONF-691053.

Reported are results from scintillation camera studies on 38 randomly selected patients with urological disorders. Following intravenous administration of ^{131}I-labeled ortho-iodohippuric acid, radioactivity over the renal area was measured with an Anger camera employing electronic crystal splitting. It is concluded that radioisotope diagnosis represents a valuable addition to routine radiological techniques. Especially with regard to functional disturbances, radioisotopes are superior because of small radiation burden, simplicity of procedure, and feasibility of frequent repetition. With respect to morphological problems, the isotope method can be regarded as a screening test. (H.B.G.)

21765 DIAGNOSIS OF BONE METASTASES IN PROSTATE CARCINOMA WITH ^{87m}Sr AND ANGER CAMERA. Aberle, B.; Hoefer, R.; Willvonseder, R. (Urologische Univ., Vienna. Medizinische Univ., Vienna). Helv. Chir. Acta; 37: 534-7(Aug 1970). (In German).

From Joint Meeting in Austrian and Swiss Society for Urology, Bregenz, Austria. See CONF-691053.

In 19 patients suffering from prostatic carcinoma X-ray examinations as well as blood chemical findings are compared with the results of bone scintigraphy using ^{87m}Sr. The diagnostic value of bone scintigraphy for the urologist is discussed with special reference to therapy. (auth)

21766 METHOD FOR MEASURING OVERALL HEPATIC BLOOD FLOW USING RADIOACTIVE XENON. Amiel, M.; Espinasse, P.; Rubet, A. (Hopital Edouard-Herriot, Lyon). J. Radiol., Electrol., Med. Nucl.; 51: 683-4(Nov 1970). (In French).

A new method is proposed for measuring overall hepatic blood flow by the continuous perfusion of ^{133}Xe injected into the hepatic artery or portal vein. The principle of this method has already been applied with ^{85}Kr for measuring cardiac blood flow, but does not appear to have been used in hepatic blood flow measurements. The method is being rapidly developed and results obtained with dogs indicate its simplicity and reproducibility. Although the method is not yet being applied to humans the limits and difficulties foreseen in its application to portal hypertension measurements are discussed. (auth) (France)

21767 USE OF METASTABLE ^{87}Sr IN LOCALIZING BONE NEOPLASMS. Spithakis, R. J. Radiol., Electrol., Med. Nucl.: 51: 680-2(Nov 1970). (In French).

The use of metastable ^{87}Sr is more accurate and more rapid than radiological examination and has certain advantages compared to scintigraphy with ^{85}Sr. A 23% improvement in radiological diagnostic ability is observed. The rate of fixation is variable and the suspected zones always hyperfixed. The positivity of the scintigraphic examination with ^{87}Sr is automatically in favor of metastases except in the case of Paget's disease. (France)

21768 USEFULNESS OF A SCANNING CAMERA AS A WHOLE-BODY RADIATION METER IN THE STUDY OF THYROID CARCINOMAS. Hoefer, R.; Willvonseder, R. (Medical Clinic II, Vienna). J. Radiol., Electrol., Med. Nucl.: 51: 671-3(Nov 1970). (In French).

The use of a scanning camera as a whole-body radiation meter is recommended for the localization of metastases of a thyroid

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carcinoma in patients following the administration of ^{131}I. The variations in the results caused by the redistribution are negligible. It is useful to be able to simultaneously localize the metastasis and obtain numerical measurements. (auth) (France)

21769 HANDLING OF ^{133}Xe IN CLINICAL STUDIES. LeBlanc, Adrian D.; Johnson, Philip C. (Baylor Univ., Houston, Tex.). Phys. Med. Biol.; 16: 105-9(Jan 1971).

Xenon-133 is rapidly becoming one of the more popular agents for functional studies of the lung. It has been shown that the efficiency of extraction for gas volumes greater than 1 cc can be increased significantly by cooling the saline and the dose bottle prior to use. Leakage of ^{133}Xe from multi-injection dose bottles was found to be 5 to 6% per day even before use. This leakage could be reduced by 70 to 80% by cooling and inverting the dose bottle. Plastic syringes containing xenon solution leak approximately 0.5 to 1% per hour. The xenon was also found to extract from solution and enter into, and collect in, the plastic of the barrel and the rubber plunger as a function of time; for a 2.5 cc syringe containing 0.5 cc of xenon solution, 10% left the solution in five minutes and as much as 50% in two hours. (auth) (UK)

21770 MICROANGIOGRAPHIC STUDY OF VASCULAR RADIOLESIONS OF THE SKIN OF MICE. Minet, P. (Univ., Liege). J. Belge Radiol.; 53: 379-85(Sep-Oct 1970). (In French).

A microradiography technique for the investigation of the vascularization of the skin was developed and observations made on the healthy skin of mice are reported. The results of a study of vascular radiolesions that developed during the first 8 weeks after application of a single dose of 3,000 R on a field of 2 cm in diameter are also reported. (auth)

21771 PROGRAM FOR FISCAL 1970 OF THE NATIONAL INSTITUTE OF RADIOLOGICAL SCIENCES. Kagaku Gijutsucho Geppo; No. 167, 14-16(Jul 1970). (In Japanese).

The National Institute of Radiological Sciences, since its establishment about 12 years ago, has engaged in the studies of radiation injuries to the human body and their prevention, the uses of radioisotopes in diagnosis and therapy, medical uses of radiation, and training of personnel in the field. The salient feature in the fiscal 1970 program is studies on the utilization of cyclotron produced neutrons for medical purposes. (Japan)

21772 MAIN PRINCIPLES OF DESIGN OF A RADIATION ENDOPROBE. Gugnin, Yu. Ya.; Kalantarov, K. D. (All-Union Scientific Research Inst. on Medical Instrumentation, Moscow). Med. Radiol.; 6: No. 1, 56-60(Jan 1971). (In Russian).

The possibility of diagnostic use of radioactive indicators recorded by means of an autonomous radiation detector is discussed. The principles of design of a radiation detector probe is discussed and data on such a detector are presented. (auth)

21773 ESTIMATION OF PULMONARY SHUNT BLOOD FLOW BY CONSTANT INFUSION OF RADIOACTIVE XENON. Massey, William H.; Krippaehne, William W.; Talman, Ellen L.; Dennis, Daniel L. (Univ. of Oregon, Portland). Surg. Forum; 21: 203-5(1970).

From 26th Annual Sessions of the Forum on Fundamental Surgical Problems, 56th Clinical Congress of the American College of Surgeons, Chicago, Ill. See CONF-701014.

To evaluate the performance and operation of respiratory assist devices, a reliable method for the estimation of pulmonary shunt blood flow that is independent of administered O_2 concentration is necessary. The use of a constant infusion of ^{133}Xe to allow saturation of the pulmonary membranes, capillaries, and alveolar gases to a steady state before measuring the pulmonary shunt blood flow was evaluated. The major advantages of the method include relatively short (5 min) infusion, measurements that are independent of blood oxygen levels, no blood processing requirement, excellent reproducibility, simple calculations, and low cost. (E.E.H.)

21774 RADIOSTRONTIUM AND OSSEOUS METASTASES: PRELIMINARY CLINICAL IMPRESSIONS. Vigne, J.; Roux, G.; Amalric, R.; Spitalier, J. M. J. Radiol., Electrol., Med. Nucl.; 50: 918-19(Dec 1969). (In French).

The preliminary results obtained with ^{85}Sr in the diagnosis and location of osseous metastases are reported. The statistical study of the fixation variations for different skeletal segments showed that the knee has an almost constant fixation rate. The elevated fixation found in benign non-tumorous lesions, benign tumors, and malignant tumors is tabulated. The results as yet are not conclusive enough to confirm a hyperfixation peak indicative of osseous lesions. (J.S.R.)

21775 COMPUTER EVALUATION OF DIAGNOSTIC X-RAY SPECTRA. Gudden, F.; Mika, N.; Reiss, K.-H. (Siemens AG, Erlangen, Ger.). Stud. Biophys.; 23: 243-7(1970). (In German).

Using a Ge(Li) crystal as a detector the bremsstrahlung spectra emitted by a commercially available x-ray tube were measured. The voltage on the tube was varied between 40 and 130 kV in steps of 10 kV. These spectra were used as the input data for the calculation of other data that can be helpful in the optimization of medical x-ray diagnostic procedures. (auth)

21776 PROSPECTS AND IMPORTANCE OF ISOTOPIC DOUBLE LABELING IN NUCLEAR MEDICINE. Kertesz, Laszlo (Univ. of Medical Sciences, Budapest). Atomtech. Tajek.; 13: 370 >1(1970). (In Hungarian).

Double labeling involves the simultaneous use of two different radioisotopic tracers; during the last decade, the technique gained increasing application in nuclear medicine, as the result of the increased availability of suitable isotopes. The specific methods are described, and the advantages and difficulties for applications in nuclear medicine are discussed. Methods based on the non-simultaneous application of the tracers and detection techniques are also discussed. (52 references) (TTT)

21777 RENAL SCINTIGRAPHY WITH ^{99m}Tc-IRON ASCORBATE COMPLEX. Buraggi, G. L.; Rodari, A. (Univ., Milan). Radiol. Med.; 56: 408-20(May 1970). (In Italian).

The results obtained by the use of ^{99m}Tc-iron ascorbate complex in renal scintigraphy are reported. The distribution of the radioactive tracer is particularly convenient for its use in the renal scintigraphic field; the highest values of the ratio between the renal radioactivity and that of the body are obtained about half an hour after administration and for activities of 1 to 2 mCi, they last for about three hours. The use of higher activity allows good scintigraphic results to be obtained 20 to 24 hours after administration. For evaluating renal function the behavior of ^{99m}Tc-iron ascorbate complex gives less interesting results than radiohippuran. The scintigraphic results obtained by ^{99m}Tc-iron ascorbate complex have always been very satisfactory; often they are better than those obtained by tracers of the mercurial diuretic group; some examples of these results are reported. The dosimetric evaluation obtained by the usual methods of calculation leads to the conclusion that the doses absorbed at the level of the kidneys, body and gonads are lower than those obtained with any other radioactive substance used up to the present time (for the kidneys from a fifth to a fiftieth of the doses obtained using Neohydrin ^{197}Hg). ^{99m}Tc-iron ascorbate complex must therefore be considered as the preferred compound to be used in renal scintigraphy. (auth)

21778 SIMULTANEOUS REGISTRATION OF VENTILATION AND PERFUSION OF THE RIGHT AND LEFT LUNG IN RABBITS WITH A RADIOSPIROMETRIC TECHNIQUE. Dale, Knut (Inst. of Occupational Health, Oslo. Karolinska Sjukhuset, Stockholm. Malmoe Allmaenna Sjukhus, Sweden). Scand. J. Resp. Dis.; 51: 125-32(1970).

The use of rabbits for testing a radiospirometric technique using ^{133}Xe and external detectors is detailed. The ventilation and perfusion could be measured separately for each lung under steady-state conditions. Using intravenous injections of ^{133}Xe, the perfusion was directly related to the maximum counting rate of ^{133}Xe, and the relative ventilation was calculated from the initial ^{133}Xe wash-out rate. The principles of this steady-state technique for studying regional lung function are discussed. This technique was developed to study the pathophysiology of unilateral silicosis induced in the basal part of the right lung in experimental animals. Therefore the upper parts of the lungs were shielded during the measurements. The geometry is described, and the source of error due to scattering radiation was investigated both in vivo and by model experiments. Normal animals were also investigated with the technique. There was a smaller scatter in the distribution of ventilation between the lungs than in the distribution of perfusion. Both the results obtained from testing of the method and from normal controls indicate that the radiospirometric technique is satisfactory for studies on unilateral induced silicosis in rabbits. (auth) (Denmark)

Radiotherapy

Refer also to abstracts 21608, 21694–21696, 21704, 21708, 21709, 21711, 21848, 21887, 21909, 21911, 21912, 21921, and 22062.

21779 RADIO-CHEMOTHERAPY OF PLEURAL METASTASES SECONDARY TO PRIMARY TUMORS OF THE LUNG. Nuvolone, U.; Savino, G.; Sorrentino, R. (Ospedale Maggiore, Novara, Italy). Med. Nucl.-Radiobiol. Lat.; 12: 55-62(1969). (In Italian).

The results obtained with combined chemotherapy and radiotherapy in 47 cases of pleural effusion due to primary cancer of the lung are reported. Good palliative results were achieved. It was concluded that the formation of effusion could be delayed or arrested and an objective improvement was obtained in most cases. (auth)

21780 BLOOD COAGULATION IN DOGS SENSITIZED BY DINITROCHLORBENZOL AFTER IRRADIATION. Romanenko, G. F.; Yakunin, G. A. Tr. 1 (Pervogo) Mosk. Med. Inst.; 58: No. 2, 16-18(1968). (In Russian).

Blood coagulation in dogs sensitized by chlorodinitrobenzene (CDB) following local x irradiation was studied by the thromboelastographic method following four to six treatments by low dose radiotherapy with 150 R per treatment and total dose of 450 R. The results showed that the coagulation, formation, and retraction of blood clots in dogs sensitized by CDB after repeated x-ray therapy depends not only on the plasma and thrombocytic components but also on the qualitative changes of fibrinogenesis and thrombocytes. Data obtained confirmed the importance of limiting the use of x-ray therapy in dormatological practices. (R.V.J.)

21781 PROCEEDINGS OF THE 26th ANNUAL SESSIONS OF THE FORUM ON FUNDAMENTAL SURGICAL PROBLEMS, 56th CLINICAL CONGRESS OF THE AMERICAN COLLEGE OF SURGEONS, CHICAGO, ILLINOIS, OCTOBER, 1970. Surg. Forum; 21: 1-552(1970). (CONF-701014).

Two-hundred-fifty-four articles are included; separate abstracts were prepared for five. The remaining 249 papers contain information on: shock; wound healing-protein metabolism, endocrinology and metabolism; tumors; cardiac problems; pulmonary infection; immunologic problems in organ transplantation; gastric physiology, small intestinal physiology; liver, biliary, and pancreatic problems; gynecology and obstetrics; neurologic surgery; orthopedic surgery; otorhinolaryngology; plastic surgery; and urologic surgery. A separate author index is included. (E.E.H.)

For abstracts of individual papers see: 21535, 21604, 21773, 21782, and 21848.

21782 CYANOACRYLATE MONOMERS IN ANASTOMOSIS OF IRRADIATED INTESTINE PREVENTING ANASTOMOTIC LEAKS. Sterchi, Michael; James, Paul M.; Jr.; Myers, Richard T. (Bowman Gray School of Medicine, Winston-Salem, N. C.). Surg. Froum; 21: 332-4(1970).

From 26th Annual Sessions of the Forum on Fundamental Surgical Problems, 56th Clinical Congress of the American College of Surgeons, Chicago, Ill. See CONF-701014.

Operating on postirradiation intestine has resulted in a large number of complications. Of 48 patients treated with ortho-volt or super-volt radiation therapy over the last eight years, and subjected to bowel anastomosis, 43% developed clinically apparent leaks at their line of anastomosis. Experiments were conducted on 32 dogs using radiation followed by either ileocolic or ileoileal anastomosis. The anastomoses were then sprayed with cyanoacrylate aerosol. None of the spray groups developed fistulae. Eight patients with advanced carcinomas were operated on and had their anastomoses sprayed with isobutyl 2-cyanoacrylate monomer. It was concluded that cyanoacrylate monomers are helpful in preventing fistulae in the anastomotic lines of the irradiated bowel and, although they are present in the tissue for long periods of time, no evidence of toxicity has been noted. (E.E.H.)

21783 OPHTHALMOLOGICAL APPLICATORS USING ^{90}Y. Sokolov, V. A.; Timofeev, L. V.; Bochkarev, V. V.; Kostyukova, T. D.; Kondrat'eva, T. I. (Inst. of Biophysics, Kiev). Med. Radiol.; 6: No. 1, 9-12(Jan 1971). (In Russian).

Applicators of ^{90}Y are proposed for the treatment of malignant tumors of the eyes and appendages. They consist of two-layer disks 10 and 15 mm in diameter and besides a β emitter contain a protective layer. Collargol is used for marking the protective layer. The base of the applicator consists of a number of substances (gelatin, polyvinyl alcohol, glycerine, etc). This enabled the use of the technique of tissue-equivalent media for the calculation of dose fields. Dose fields for applications of different diameters were calculated. (auth)

21784 X-RAY THERAPY OF NONTUMOROUS DISEASES. Pereslegin, I. A.; Khodyrev, V. I. (Inst. of Medicine, Moscow). Med. Radiol.; 6: No. 1, 6-9(Jan 1971). (In Russian).

The efficacy of low doses of x rays in the treatment of some nontumorous diseases is discussed. The diseases treated included arthritis, bursitis, inflammations, osteomyelitis, phlebitis, spondylitis, and synostosis. Exposure to single doses were within the limits of 5 to 15 R. The total dose in degenerative-dystrophic processes did not exceed 250 R, whereas in inflammations the total dose did not exceed 150 R. Two-year follow-up of patients after therapy revealed good effectiveness and a complete clinical recovery in 93% of cases. (auth)

21785 TREATMENT OF MALIGNANT TUMORS WITH HIGH DOSES OF NITROGEN MUSTARD (TS 160) AND/OR HIGH DOSES OF IONIZING RADIATION UNDER THE PROTECTION OF AUTOLOGOUS BONE MARROW (EVALUATION AFTER A PERIOD OF 7 YEARS). Kolar, V.; Kadlecova, D. (Oncological Inst., Brno). Neoplasma; 17: 535-40(1970).

An evaluation, covering a period of 7 years, was made on the treatment of malignant tumors with high single doses of nitrogen mustard (TS 160) or high doses of ionizing radiation (x or cobalt-60 γ) under the protection of autologous bone marrow. Forty-one patients with advanced solid malignant tumors and three patients without demonstrable signs of malignant tumor dissemination following surgery were evaluated. A significant protective effect of bone marrow was ascertained. The therapeutic results were not encouraging, however, except in the prolongation of survival time in three patients with advanced tumors. In the patients previously treated by radical operation and a patient with a small solitary tumor, the therapy failed to delay the onset of relapse. Possible causes of the results obtained and the failures sustained are discussed. (auth)

21786 SITE AND INDICATION FOR EXTERNAL RADIOTHERAPY OF CANCER OF THE UTERINE CERVIX. Sarrazin, D. (Institut Gustave-Roussy, Villejuif, France). J. Belge Radiol.; 53: 364-78(Sep-Oct 1970). (In French).

The method of treatment of all stages of cervical cancer should, with some modifications, follow the same general pattern. Radium therapy followed by external radiotherapy should be used for small cancers. The treatment should be reversed for larger cancers and in more advanced stages. The association of these two methods must be recognized as two successive stages of one treatment. The success of the therapy depends on good topographic and chronologic adaptation to the malignancy and a better knowledge of dosimetry. (auth)

21787 APPARATUS FOR EFFECTING MEDICAL TREATMENTS WITH RADIO ACTIVE ISOTOPES. (to Nuclesa-Nuclear Engineering and Equipment S.A.). British Patent 1,219,604. 20 Jan 1971. Priority date 19 Jul 1967, Switzerland.

A radioapplicator is designed which employs a pneumatic transport system for transporting and positioning the radioisotope source in the probe tip. (W.H.K.)

21788 BODY CONTOUR FOR RADIOTHERAPY. Meredith Brown, D. E. (North Staffordshire Radiotherapy Centre, Stoke-on-Trent, Eng.). Brit. Med. J.; 3: 345(8 Aug 1970).

The Temco Formulator is briefly described. The portable instrument is designed to record body contours for transferring to paper and computing isodose plans. It consists of rows of parallel aluminum sensing needles mounted in such a way as to move independently. A wing nut tightens the needles between bars after recording the body contours. More than one formulator may be clamped together. (UK)

21789 PERSONAL EXPERIENCE WITH ^{60}Co SEEDS IN THE TREATMENT OF TUMORS OF THE ESOPHAGUS AND MAZILLARY SINUS. Ferolla, G.; Fontana, C.; Pompei, G. (Univ., Modena, Italy). Minerva Radiol.; 15: 163-71(May-Jun 1970). (In Italian).

Personal experience in the local treatment of esophageal and maxillary sinus tumors with ^{60}Co is reported. The shape and physical and biological properties of the radioactive seeds are discussed and reference is made to the problems posed by exact dosimetric evaluation. The principal fields and techniques are explained. The results were encouraging with respect to both palliation and cure and it is suggested that the method should be employed either with or without surgery or other radiotherapeutic techniques. (auth)

21790 TREATMENT OF CANCER OF THE THORACIC ESOPHAGUS (DATA FROM 755 CASES). Gary-Bobo, J. J. Radiol., Electrol, Med. Nucl.; 50: 920-3(Dec 1969). (In French).

At the C.R.I.C. of Montpellier, from 1956 to 1968, 755 cases of esophagus cancer were treated; some by surgical excision and some by radiotherapy. The results showed that with surgery there was only a 15% survival after five years and with radiotherapy alone the survival rate was only 3%. Since 1967, surgery has been associated with radiotherapy. The results to date have

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been satisfactory: reduced operation mortality, irradiation well supported, and apparent increased survival. (J.S.R.)

21791 NEW METHOD FOR IRRADIATION OF COMPLEX REGIONAL VOLUMES. EXPERIENCE GAINED AND PERSPECTIVES. Abbatucci, J. S.; Quint, R.; Roussel, A.; Bloquel, J.; Urbajtel, M. J. Radiol., Electrol., Med. Nucl.; 50: 907-10 (Dec 1969). (In French).

The additive and substractive techniques for the irradiation of complex body regions in radiotherapy are briefly described. An improvement to the subtractive technique is reported. Its principles are that the volume-target is determined by reference radiographies, the geometries of the reference and irradiation are completely identical, and protection is given by lead sheets. Polystyrene cut to the same volume as the target-volume has identical geometry to that of the reference and irradiation. Extensions of this technique are discussed. (J.S.R.)

21792 DESCRIPTION AND PRELIMINARY TESTS ON THE CURIETRON (POLYVALENT PROJECTOR OF RADIOACTIVE SOURCES PERMITTING COMPLETE PROTECTION IN GYNECOLOGICAL CURIETHERAPY). Chassagne, D.; Delouche, G.; Rocoplan, J. A.; Pierquin, B.; Gest, J. (CEN, Saclay, France). J. Radiol., Electrol., Med. Nucl.; 50: 910-13(Dec 1969). (In French).

A curietron was constructed on the following principles: simple and sturdy mechanical conception with ease in placing and removing sources, mobile and light as possible, one device using from 1 to 4 radioactive sources simultaneously and separately, absolute security, and universal application in all present situations. The curietron construction is described. Preliminary tests were made on the electromechanical and clinical planes, which gave acceptable results. (J.S.R.)

21793 TWO-FIELD TELECOBALT IRRADIATION OF THE LYMPH AREA OF CANCER OF THE UTERINE CERVIX. Kuhn, Endre; Gyudi, Sandor. Magy. Radiol.; 22: 309-16(Oct 1970). (In Hungarian).

Complementary telecobalt irradiation of the regional lymph area of cancer of the uterine cervix was carried out using central and dorsal fields, 15 × 15 cm in size. In the middle of the fields, previously cavitarily irradiated organs were overshadowed by a 5 half-layer lead wedge and the margins of the fields were bordered by 7.5 half-layer lead blocks, parallel with the line of the parailiac lymph chain. The characteristic dose distribution is practically independent of body thickness. During 23 days, a 4000-rad focus-dose is administered in 20 fractions. The contra-indications of the method and the clinical observations are considered. (auth)

21794 EFFECT OF EXTENDED-FIELD RADIOTHERAPY ON PERIPHERAL BLOOD VALUES IN ADVANCED HODGKIN'S DISEASE. Hoest, Herman (Norwegian Radium Hospital, Oslo). Scand. J. Haematol.; 7: 304-8(1970).

Twenty patients with Hodgkin's disease clinically in stage III were studied during and after extended-field x radiotherapy. Treatment consisted of two courses of four to five weeks duration separated by a six week interval. The first course of treatment was directed at the region which contained the predominant lymph node swelling, all the nodes either above or below the diaphragm; the second to the remaining, untreated lymph nodes either below or above the diaphragm. Only a slight depression of peripheral blood cell counts occurred after the first course, but marked depression was evident during and after the second. Three deaths occurred shortly after treatment in patients with impaired bone marrow function and in another three patients severe bleeding attributable to thrombocytopenia occurred during the second course. This effect on the bone marrow may be a serious objection to extended-field radiotherapy of advanced Hodgkin's disease. (auth) (Denmark)

21795 HEMOLYSIS IN PATIENTS WITH CHRONIC LYMPHOCYTIC LEUKEMIA DURING EXTRACORPOREAL IRRADIATION OF THE BLOOD. Andersen, Vagn; Karle, Hans; Dige-Petersen, Harriet (Rigshospitalet, Copenhagen). Scand. J. Haematol.; 7: 222-32(1970).

Erythrocyte destruction was studied in six patients with chronic lymphocytic leukemia treated with extracorporeal irradiation of the blood (ECI). Before treatment all patients were anemic and ^{51}Cr-labeling of erythrocytes showed an apparent half-life of 14 to 19 days, indicating a reduced erythrocyte life span and ^{59}Fe-data were suggestive of random destruction of erythrocytes in four of the six patients. During the later part of the ECI period considerable reticulocytosis developed, and increased disappearance rate of ^{51}Cr-label was evident after a mean cumulative erythrocyte dose between 18,500 and 34,000 rads had been reached. This indicates the occurrence of hemolysis which was most pronounced in the one patient with a slightly positive Coombs' test. The ^{59}Fe-curves were either unaffected by the irradiation or showed only minor effects; since labeling was performed immediately before treatment, this indicates that young erythrocytes are less radiosensitive. (auth) (Denmark)

21796 CHANGES IN THE METHODS OF RADIOTHERAPY OF GYNECOLOGICAL CANCERS WITH THE USE OF ULTRAHARD AND ULTRAPENETRATING RADIATION. Sommer, F.; Schmidt-Hermes, H. (Univ., Homburg, Ger.). J. Belge Radiol.; 53: 204-6 (May-Jun 1970). (In French).

A new technique for radiotherapy of gynecologic cancer using ultrahard x rays is described. The advantages of ultrahard x rays over telecobalt therapy are stressed. The method involves percutaneous irradiation using a 42 MeV Siemens Betatron in combination with internal radium. This allows an equal radiation repartition of the pelvis minor with 25 MeV photons while avoiding the central part already irradiated with radium. (E.R.B.)

21797 LAZERY V BIOLOGII I MEDITSINE. (Lasers in Biology and Medicine). Kavetskii, R. E.; Chudakov, V. G.; Sidorik, E. P.; Gamaleya, N. F.; Kogut, T. S. Kievskaya Knizhnaya Fabrika No. 1. Kiev: Izdatel'stvo Zdorovya (1969). 259p.

For the first time in the Soviet Union, the foreign and domestic literature on the biological effects of radiations from optical quantum generators (lasers) and their applications in experimental biology and in medicine is analyzed, classified, and summarized. The literature covers the period from the time of the development of the laser to the present date. Studies at the Kiev Scientific Research Institute of Experimental and Clinical Oncology on the mechanisms of laser radiation effects on normal organs and tissues, tumor cells in tissue cultures, and the growth and development of experimental tumors are also presented. Their effects on tumors are the basis for their use in medicine, particularly in the treatment of patients with malignant tumors. Questions regarding the safety of laser personnel are discussed in detail. The book is designed for use by physicians, oncologists, radiologists, surgeons, neurologists, ophthalmologists, otolaryngologists, pathophysiologists, and also biophysicists, cytologists, biologists, and engineer-radiologists. An extensive bibliography is included with references in English also. (tr-auth)

21798 ELECTROCARDIOGRAPHIC STUDIES OF PATIENTS IRRADIATED ON THE THORAX WITH A 42-MeV BETATRON. Garbagna, P.; Nicolato, A.; Milani, O. (Univ., Pavia, Italy). Nunt. Radiol.; 34: 1697-1712(Dec 1968). (In Italian).

Electrocardiagraphic studies were repeated on patients following thorax irradiation with the 42-MeV betatron. However, few cardiac changes were noted. It was concluded that irradiation of the thorax with either photons or electrons can be used, from the viewpoint of cardiac alterations, with relative confidence either in cardiopathic patients or in patients with no cardiac lesions. (tr-auth)

21799 IRRADIATION OF TUMORS OF THE INTERNAL MAMMARY LYMPHATIC CHAIN IN MAMMALS. INSERTION OF A LENTICULAR FILTER IN CONVENTIONAL ROENTGENTHERAPY. Cecchetti, E.; Teofoli, B.; Putti, C.; Caretti, G. (Univ., Bologna). Radiobiol. Radioter. Fis. Med.; 24: 245-57(Jul-Aug 1969). (In Italian).

A review is presented of the various methods and techniques of irradiation of the internal mammary lymphatic chains. The design is reported of a compensation lenticular filter that was used to control the dose distribution of ^{60}Co and ^{137}Cs γ beams. (P.B.M.)

21800 CLINICAL TRIALS IN RADIOTHERAPY AND THE MERITS OF HIGH ENERGY PHOTONS. Graffman, S.; Jung, B. (Uppsala Univ.). Acta Radiol., Ther., Phys., Biol.; 9: No. 1, 1-23 (Feb 1970).

The physical, radiobiologic, and radiotherapeutic properties of high energy protons are summarized and tentative dose distributions for the treatment of tumors in the pharynx, esophagus, lungs, urinary bladder, and uterus constructed. The dose distributions conform well with established criteria but the beneficial effects to be gained from them cannot be assessed quantitatively. A crude tumor model indicates that 0.10 difference in cure rate between two therapy protocols is more than can be expected in most cases. Reassessment of results from clinical trials seems to confirm this estimate. Other measures of the clinical efficiency such as the mean log survival time and the local response may be more sensitive but are probably not good measures of the effect searched for. The conclusion is that of the order of 1000 patients should be entered in each

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group of a clinical trial if the difference that can be expected is to be demonstrated significantly with a fair probability. (auth) (Sweden)

21801 ASPECTS OF GENERAL RADIOLOGY. 9. RADIOLOGICAL AND DOSIMETRIC PROBLEMS IN INTERNAL OR METABOLIC ISOTOPE THERAPY. Casati, Annibale. Radiol. Med.; 56: 421-32(May 1970). (In Italian).

Special relationships exist between the physical and the biological factors in the radiobiological process involved in internal or metabolic isotope therapy. The biological factor effects the physical one in the sense that uptake is a result of a biological process in the normal e.g., thyroid cell and a pathobiological process in the tumor cell (e.g., uptake of labeled 1-glucose by hepatoma and Yoshida's ascites tumor): this factor acts throughout the fixation time or the time of its presence in the target cell and a biological half-life period (T_{biol}) can be determined. The physical factor acts both continually and continuously in time on the target cell until the point of complete decay, thus impeding the anatomical and functional recovery of the part of the cell that follows immediately upon the end of the irradiation. Dosimetry, particularly when pure β emitters such as ^{14}C are used, is made especially difficult by reason of the fact that direct evaluation in vivo is impossible. Doses must therefore be based on total destroyed mCi/unit of time; these will later be converted to rad/time and, if possible, to rad/time/g. They are, of course, approximate doses. Lack of precision in physicodosimetry, however, is countered by histological evidence of deep, serious and irreversible cell changes. The use of ^{14}C-labeled 1-glucose in the treatment of pleural and peritoneal tumors is recommended. (auth)

21802 INTERSTITIAL TREATMENT OF NEOPLASMS BY MEANS OF ^{192}Ir. Danczak, Zofia (Instytutu Onkologii, Warsaw). Nowotwory; 20: 89-93(Apr-Jun 1970). (In Polish).

Treatment of certain neoplasms of cavity, skin, and of penis by means of ^{192}Ir was introduced in the Oncological Institute in Warsaw in November 1967. The method used is based on the preparation of after-loading application followed by the control of physical dosimetry. The doses applied were from 6,000 to 7,000 R per tumor. 68 patients including 16 with tongue carcinoma, 3 with cancer of the base of the oral cavity, 2 with cheek mucosa carcinoma, 31 with the lip carcinoma, 7 with skin carcinoma and 9 with cancer of the penis were given therapy for a two-year period. Early failures were observed in 3; necroses in 2 patients. Cosmetic and functional effects are very good. Post-irradiation reactions are milder and shorter than after treatment with radium. (auth)

21803 ROLE OF IRRADIATION IN THE TREATMENT OF CARCINOMA CERVIX UTERI: A REVIEW OF 997 CASES. Kurrle, G. R. (Cancer Inst., Melbourne). Aust. N. Z. J. Obstet. Gynaecol.; 10: 230-7(1970).

The results of treatment of carcinoma of the cervix uteri in Melbourne are reviewed, with particular reference to the role of irradiation. Comparison is made between combined radio-surgical treatment and irradiation alone. (Australia)

21804 EPIDERMOID CARCINOMA OF THE TONGUE AND OF THE FLOOR OF THE MOUTH. An Investigation of 245 Cases Treated at the Institut Gustave-Roussy. Pierquin, B.; Chassagne, D.; Cachin, Y.; Baillet, F.; Fournelle le Buis, F. (Institut Gustave-Roussy, Villejuif, France). Acta Radiol., Ther., Phys., Biol.; 9: 465-80(Oct 1970). (In French).

The results of the treatment of 245 patients with epidermoid carcinoma of the tongue or floor of the mouth by means of endocurietherapy with radium or iridium-192 are discussed. A considerable difference in the reaction of the primary growth over a three-year period was evident. With tumors less than 4 cm in diameter the rate of recurrence was of the order of 3 percent with iridium-192 while it reached 35 percent with radium. The new techniques reduced the risk of local recurrence to an almost negligible figure. The three-year survival rate for the whole group was 46 percent. (auth) (Sweden)

Blast and Thermal Effects

Refer also to abstract 21713.

Radiation Effects on Animals

Refer also to abstracts 21590, 21597, 21749, and 21797.

21805 PHOTOPHYSIOLOGY. CURRENT TOPICS IN PHOTOBIOLOGY AND PHOTOCHEMISTRY. VOLUME V. Giese, Arthur C. (ed.). New York; Academic Press, Inc. (1970). 303p.

Separate abstracts were prepared for three chapters. The remaining five chapters are concerned with chemical, biological, and physical properties of singlet oxygen, photosynthesis, and photophysiology of vertebrate color vision. (H.L.W.)

For abstracts of individual chapters see: 21806, 21807, 21870.

21806 ACTION OF ULTRAVIOLET LIGHT ON MAMMALIAN CELLS. Painter, Robert B. (Univ. of California, San Francisco). Photophysiol. Curr. Top.; 5: 169-89(1970).

A review of the literature on ultraviolet effects on mammalian cells includes studies on effects of uv on thymine dimers in DNA of cells of hamsters, rabbits, and man; uv-induced chromosome aberrations; effects of uv on reproductive integrity of asynchronous and synchronous populations; action of base analogues, caffeine, and other agents that enhance uv-induced lethality; effects of fractionated doses; and effects of uv on DNA, RNA, and protein synthesis. Studies on repair of uv-damaged mammalian DNA include lack of photoreactivation in placental mammals; repair replication and unscheduled DNA synthesis; and significance of repair synthesis. Studies are also reviewed on the action of uv on progression through the cell cycle and the effects of uv microbeams. (H.L.W.)

21807 PHOTOREACTIVATION IN ANIMAL CELLS. Cook, John S. (Univ. of Tennessee, Oak Ridge. Oak Ridge National Lab., Tenn.). Photophysiol. Curr. Top.; 5: 191-233(1970).

A review of the literature on photoreactivation in animal cells is presented. In a discussion of photoreactivable lesions in DNA, the role of photoreactivating enzymes in the repair of radioinduced dimers is emphasized. A review of assays for photoreactivation includes a discussion of the following processes: light-dependent, heat-sensitive repair by cell-free extracts of uv-irradiated transforming DNA; light-dependent, heat-sensitive ability of cell-free extracts to monomerize pyrimidine dimers in uv-irradiated Escherichia coli DNA; light-dependent monomerization of pyrimidine dimers in vivo; and competition of DNA from uv-irradiated cells with heterologous DNA in an in vitro system. A review of studies on distribution of photoreactivating activity in various animal phyla includes studies on protozoans, echinoderms, arthropods, amphibians, fish, reptiles, birds, and mammals. A review of studies on mammals and mammalian cells led to the conclusion that direct photoenzymatic photoreactivation does not occur in placental mammals. Studies on tissue distribution of photoreactivating activity in sea urchins, crabs, frogs, and other animals showed that if the photoreactivating enzyme occurred at all, it was widely distributed throughout the entire organism. Studies on effects of age of the organism on distribution of photoreactivating activity are reviewed for Bracon, Drosophila, and chickens. Subcellular distribution of photoreactivating activity was studied with regard to the nucleus, mitochondria, chloroplasts, cytoplasm, and membranes. The following studies on photoreactivable biological lesions are reviewed: cell killing, inhibition of DNA synthesis, mitotic delay, mutagenesis, virus inactivation, and chromosome aberrations. Developmental effects are reviewed for echinoderms, insects, and amphibians. It was found that in the development of amphibian larvae only the surface structures were affected by uv irradiation. (H.L.W.)

21808 ON CHROMOSOME RADIOPROTECTION IN VITRO: TESTS WITH METHIONINE, ASPARTIC ACID, LEUCINE, AND LYSINE. II. Romito, Sandro. Fracastoro; 62: 576-81(Nov 1969). (In Italian).

Human medullar cells were irradiated and substances containing amino groups (methionine, aspartic acid, leucine, lysine) were added to the cultures in order to study their radioprotective action on chromosomes. Aspartic acid, leucine and lysine showed no radioprotective action, but methionine did. (auth)

21809 SURVIVAL CHARACTERISTICS OF MAMMALIAN CELL LINES AFTER SINGLE OR MULTIPLE EXPOSURES TO ROENTGEN RADIATION UNDER OXIC OR ANOXIC CONDITIONS. Littbrand, Bo. (Karolinska Mediko-Kirurgiska Institutet, Stockholm). Acta Radiol., Ther., Phys., Biol.; 9: 257-81(Jun 1970).

The survival parameters of different cell lines were studied after exposure to roentgen radiation. Oxygen effected both production and repair of radiation damage. The extent of these processes varied in the different cell lines. (auth) (Sweden)

21810 MULTIPLICATION OF TUMOR CELLS IN VITRO AFTER OXIC OR ANOXIC EXPOSURE TO ROENTGEN RADIATION. Littbrand, Bo. (Karolinska Mediko-Kirurgiska Institutet,

Stockholm). Acta Radiol., Ther., Phys., Biol.: 9: 337-52(Aug 1970).

An investigation was performed with cultures of the ELD ascites tumour to obtain information on the multiplication of cells irradiated with a single or a split dose of radiation in the presence or absence of oxygen. Oxygen enhanced the radiation damage concerned with clonogenic capacity to a greater extent than the damage concerned with growth retardation. Recovery due to fractionation was observed for both types of damage. The reaction of the cell strains appears to be related to differences in their ploidy grade and the content of inherent nonprotein bound sulphydryl groups. (auth) (Sweden)

21811 SURVIVAL OF A TUMOR KEPT IN A TYPICAL BIOLOGICAL CULTURE AFTER X-RAY IRRADIATION. Beaupain, Rene (CNRS, Nogent-sur-Marne, France). Compt. Rend., Ser. D; 271: 2399-2402(21 Dec 1970). (In French).

A living strain of the tumor Z 200, kept in a typical biological broth, was obtained after x-ray irradiation using a single dose of 600 R. This dose led to the disintegration of a large fraction of the tumorous nodule, small patches of living tissue remaining. These resumed their growth during successive reseedings and survived in standard biological cultures in the same way as the nodules of the nonirradiated strain. (auth) (France)

21812 CHANGES OF REACTIVITY IN ANIMALS IRRADIATED BY IONIZING RADIATION. Gorizontov, P. D. Patol. Fiziol. Eksp. Ter.: 12: 5-11(Jul-Aug 1968). (In Russian).

A brief review is presented on the effects of radiation on immune reactions of organisms. Various aspects of immune reactions are discussed including disorders of the macrophages of the reticuloendothelial system, auto-allergic reactions, and functional changes of the nervous and endocrine systems. It is emphasized that immune reactions are a result of functional changes in the cells in addition to systemic changes in the irradiated organism. (R.V.J.)

Invertebrates

Refer also to abstracts 21540, 21612, 21620, 21629, 21630, 21632, 21652, 21668, 21970, and 21994.

21813 (ANL-7760(Pt.2), pp 202-7) A COMPARISON OF RECOVERY FROM α- AND γ-RAY-INDUCED MITOTIC DELAY IN FERTILIZED SEA URCHIN EGGS. Failla, Patricia M. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969-June 1970.

Recovery from the mitotic delay caused by fertilizing sea urchin (Arbacia punctulata) eggs with γ-irradiated sperm has been previously studied and described. Experiments to test for similar recovery when the division delay is caused by α irradiation of the sperm were negative. This result is consistent with observations in other systems that there is little or no recovery from damage induced by densely ionizing radiation. (auth)

21814 (TID-24270, pp E.17-24) EFFECTS OF RADIATION ON A POPULATION OF THE PUERTO RICAN TREE SNAIL, CARACOLUS CARACOLLA. Heatwole, Harold; Rossy, Abel; Colorado, Isabel; Amadeo, Rita (Puerto Rico Univ., Rio Piedras).

From Tropical rain forest.

A study of populations of the large snail Caracolus caracolla was made by capture, measurement, marking, and recapture in the Radiation and South Control Centers at El Verde, Puerto Rico, before and after γ irradiation. With evidence from microdosimeters attached to individual snails, smaller doses than expected were found on the basis of their location in reference to the source owing to the tendency of the snails to spend part of their time under rocks. Some snails survived 29 kR. There was no consistent evidence for a direct radiation effect on size or location of homesite range. Irradiation did not cause widespread mortality, although indirect evidence suggested increased mortality close to the source. Neither growth rates nor season of growth appeared to be affected by radiation. although abnormal deposition of shell was noted in some snails after irradiation. (auth)

21815 (TID-24270, pp E.95-101) AQUATIC COMMUNITIES IN BROMELIAD LEAF AXILS AND THE INFLUENCE OF RADIATION. Maguire, Bassett Jr. (Texas Univ., Austin. Dept. of Zoology).

From Tropical rain forest.

Faunas in the water held in the leaf axils of bromeliads were examined, and association coefficients were calculated for combinations of species groups to characterize communities. Positive associations were found between harpacticoids and oligochaetes and between cyclopoid copepods, ostracods, and nauplii but not with harpacticoid copepods and nauplii. Glass jars simulating microhabitats for small aquatic organisms were arranged in the Radiation and South Control Centers and seeded with river water and with sterile distilled water to study rates of dispersal. After the glass jars were irradiated, faunas were collected, and the numbers of species were studied. Almost no differences were found between species in the Radiation Center and those in the South Control Center or with the height of jars, including those exposed to 100,000 R or more. Dispersal and community regenerative mechanisms were shown to be effective in reestablishing populations within 2 wks. (auth)

21816 (TID-24270, pp E.103-4) NEMATODES IN THE LITTER AND SOIL OF EL VERDE RAIN FOREST. Coleman, David C. (Georgia Univ., Athens).

From Tropical rain forest.

Samples of litter and soil from the Puerto Rican rain forests were censused for nematodes in the Radiation, Control, and Cut Centers. The average biomass per square meter was about 8 to 10 mg, only 10^{-2} to 10^{-3} the amounts found in many temperate grassland and forest areas. Reasons for this marked decrease and for the extent of its duration throughout the year were unknown. (auth)

21817 (TID-24270, pp E.105-22) RADIATION AND THE TERMITES AT EL VERDE. McMahan, Elizabeth A. (North Carolina Univ., Chapel Hill).

From Tropical rain forest.

Comparisons of nest condition, tunnel occupancy, and behavior were made between rain forest termites in an irradiated area and others outside the area. Most of these studies were carried out 14 to 17 mon after exposure of the area to a cesium source. Follow-up checks on nest condition were made 27 and 39 mon after exposure. Active nests receiving doses of 1000 R and up were badly eroded and contained no developing brood in contrast to the condition of active nests outside the Radiation Center. Carbon dioxide release from irradiated nests decreased. Tunnels within a 30 m radius of the cesium source were abandoned to a far greater extent than those in similar control areas. All nests within 30 m of the cesium source were entirely abandoned after 24 mon. Direct effects of radiation were presumed to be responsible rather than defoliation or mechanical disturbance. Worker termites ran consistently faster in a simulated tunnel than soldier termites, and tunnel termites ran faster than nest termites; but no statistically significant difference was found in rate of movement of termites taken from the Radiation Center and those taken from outside. Nest termites tended to reverse themselves more frequently than did tunnel termites. In laboratory tests termite radiosensitivity seemed unusually high. It was suggested that social insects, which have a high degree of behavioral complexity, may be more sensitive to radiation than other insects of comparable size. (auth)

21818 (TID-24270, pp E.151-8) DIVERSITY OF MICROARTHROPODS AFTER IRRADIATION. McMahan, Elizabeth A.; Sollins, Nancy F. (North Carolina Univ., Chapel Hill).

From Tropical rain forest.

An exploratory study comparing postirradiation diversity of litter microfauna in the South Control, Radiation, and North Cut Centers was carried out in March 1967, 24 mon after irradiation. A 3 m radius circle was sampled in each center using a vacuuming technique. Radiation did not produce decreased diversity in the postirradiative growth. (P.B.M.)

21819 (TID-24270, pp E.159-67) OBSERVATIONS ON THE MOSQUITO POPULATION IN THE IRRADIATED FOREST AT EL VERDE. Weinbren, M. P.; Weinbren, B. M. (Puerto Rico Nuclear Center, San Juan).

From Tropical rain forest.

A study was made of the mosquito population in a portion of tropical rain forest at El Verde in the period 1964 to 1966 before and after a 10 kilocurie ^{137}Cs γ radiation source was exposed for 92 days. Comparison of the records of mosquito recovery from the South Control, Radiation, and North Cut Centers indicates that the mosquito populations were initially depressed to a similar extent by both radiation and cutting, but the Radiation Center was repopulated much more rapidly than the North Cut Center. The rate at which the different species could be recovered differed markedly from one area to another. The El Verde forest had few species of vertebrates and mosquitoes, but Aedes aegypti populations developed, and an epizootic of virus disease occurred in the rodent population under circumstances that suggested radiation disturbance had a part in its initiation. (auth)

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21820 (TID-24270, pp I,69-80) HOLES IN LEAVES AND THE GRAZING CONTROL MECHANISM. Odum, H. T. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

As a measure of the relative role of herbivore consumption, monthly collections of leaf fall at 55 stations were sampled for the determination of the percentage of holes in leaves due to insects and other causes. Before irradiation holes constituted 5% with little variation between mon, single stations ranging from 3 to 8%. The data indicate that herbivore consumption of leaves before their fall to the forest floor was about the same as in temperate forests and in energy flows an order of magnitude less than that of decomposer consumers of the forest floor. After irradiation, the percentage of holes and the range of values increased slightly in both the Radiation and the South Control Centers. In the shrub layer the half life of leaves was about a year in both the Radiation and South Control Centers. The highest values, 15%, were found in 1966 close to the Radiation Center where early successional recovery was rapid. Some individual stations, trees, and species had means significantly different from the general mean. An energy circuit model diagram for herbivore action shows a drain of energy upstream from the decomposers and suggests positive work for survival stability by a regulator control action on photosynthetic surfaces. Drains increase when the distribution of net photosynthesis becomes channeled among fewer species as in early radiation recovery. The relatively small increase in herbivore action at El Verde suggests that regulatory action was effective. (auth)

21821 EFFECT OF SOME CHEMICAL AND PHYSICAL FACTORS ON THE CELL OF TRICHOMONAS VAGINALIS CULTURED IN VITRO. Malyszko, Edward Rocz. Akad. Med. Bialymstoku; 14: 163-79(1968). (In Polish).

The effect of some chemical agents, components of Roiron's medium, such as synthetic vitamin C, asparagine, Hepafort-Vitamin B_{12}, methyl blue, and of nitrogranulogen, lactic acid, perhydrol on Trichomonas vaginalis was investigated. The effect of some physical agents, namely x-rays, ultraviolet and infrared rays and oxygenation upon the cell of T. vaginalis was also investigated. A marked effect of vitamin C deficiency in the medium, of the addition of nitrogranulogen to the culture or x-ray irradiation was observed; it consisted in an increase in the number of multinuclear organisms in vitro. The ultraviolet rays had a much weaker biological effect. The irradiation of T. vaginalis cultures growing in Roiron's medium with ultraviolet rays for 25 minutes and of those suspended in physiological saline for 10 minutes resulted in a decrease in their ability to multiply in the later passages. (auth)

21822 RADIATION DISINFESTATION OF CEREAL INSECTS. 2. SENSITIVITY OF SITOPHILUS ZEAMAIS AND S. ORYZAE. Mitsui, Eizo (Food Research Inst., Tokyo); Kawashima, Koji; Umeda, Keiji; Sato, Tomotaro; Miyakawa, Kikuko. Nippon Shokuhin Kogyo Gakkaishi; 17: 379-84(Sep 1970). (In Japanese).

Doses of γ radiation necessary to prevent emergence of adults from pupae, as well as lethal and sterilizing doses, were determined for Sitophilus zeamais and S. oryzae. The LD_{99} and LD_{50} doses were 7.5 and 4 krad for S. zeamais and 8 and 5 krad for S. oryzae. Adults of S. oryzae were more resistant than S. zeamais to γ radiation. There was less species difference between the radiosensitivities of the eggs, larvae, and pupae. The resistance of the developmental stages increased with age. It was found that a dose of 4 krad was lethal for eggs, and that the sterilizing dose was 10 krad. (Japan)

21823 ULTRAVIOLET REPELLENT AND LETHAL ACTION ON THE AMERICAN COCKROACH. Wharton, D. R. A. (Army Natick Lab., Mass.). J. Econ. Entomol.; 64: No. 1, 252-5(Feb 1971).

Adult Periplaneta americana (L.) is repelled by ultraviolet (uv) radiation and susceptible to its lethal action. Fertility may be reduced although adults and older nymphs are relatively resistant to uv irradiation, young nymphs are highly susceptible, so a single exposure of only 1 minute to a moderate dose results in over 50% mortality and retards growth among the survivors. (auth)

21824 LABORATORY TESTS WITH GAMMA-IRRADIATED PHORMIA REGINA. Bushland, R. C.; Streeter, Madelon (Dept. of Agriculture, Fargo, N. Dak.). J. Econ. Entomol.; 64: No. 1, 84-7(Feb 1971).

Female black blow flies, Phormia regina (Meigen); secondary screw-worm flies, Cochliomyia macellaria (F.); and Cynomyopsis cadaverina (Robineau-Desvoidy) did not remate after mating with males sterilized by a dose of 7500 rad of gamma irradiation. Of the 3 species, P. regina lived and reproduced best in the laboratory; therefore, those blow flies were studied more intensively. When pupae of P. regina were treated, a dose of 2500 rad of gamma irradiation caused about 99% dominant lethality in sperm and greatly reduced fecundity and fertility of female flies. Pupae within 2 days of completing development tolerated 20,000 rad; pupae a day older survived 30,000 rad about as well as they withstood 5000 rad. Males sterilized with 7500 rad showed only a slight reduction in length of life and mating competitiveness. (auth)

21825 EFFECTS OF ACUTE GAMMA IRRADIATION ON THE BRINE SHRIMP, ARTEMIA. II. FEMALE REPRODUCTIVE PERFORMANCE. Squire, Richard D. (North Carolina State Univ., Raleigh). Biol. Bull.; 139: 375-85(Oct 1970).

The effects of γ radiation of female reproductive performance in brine shrimp, Artemia, are reported. Fecundity is defined as the sum total of viviparous (nauplii) and oviparous (cysts) gametes produced throughout the life span of the female. Doses of 10 to 100 kR resulted in sterility while doses of 5 kR greatly reduced fecundity. Cyst hatchability data revealed no detectable dominant lethality after 1 kR although such effects did occur after 2 and 5 kR. The average number of broods decreased significantly after 2 or 5 kR. Viviparity was also inhibited at these doses. Data for survival to adulthood, adult mortality, and reproductive patterns demonstrated that genetic damage was present in those animals descended from oocytes which were treated with 2 to 5 kR. Sex ratios did not change and no decrease in survival to adulthood was noted. (E.E.H.)

21826 EFFECTS OF NUCLEAR AND CYTOPLASMIC DAMAGE BY LASER IRRADIATION IN AMOEBA PROTEUS. Fong, Betty Ann. New York; New York Univ. (1969). 112p. University Microfilms Order No. 70-16,059.

Thesis.

Amoeba proteus was subjected to nuclear micropuncture, mechanical compression, or pulse laser irradiation for studying the effects of sublethal injuries on four cytoplasmic structures: nucleus, contractile vacuole, pseudopodia, and uroid. The nucleus was punctured by impaling with a micromanipulator positioned glass microneedle, and the following reactions were observed: immediate rounding up, and cessation of pseudopodial movement, and cytoplasmic streaming. The survival and reproductive capacities of amoebae subjected either to nuclear micropuncture or laser irradiation were compared with untreated amoebae. The normal amoebae produced 100 progeny (logarithmic growth) in slightly more than 11 days. Amoebae with micropunctured nuclei developed 100 amoebae in more than 17 days. Amoebae with lased nuclei produced 100 progeny in 30 to 31 days. A few of the micropunctured or laser irradiated amoebae failed to divide. On the other hand, following either treatment, some of the incipient clones that started to develop underwent cytolysis, suggesting that the injuries persisted through several generations. (Diss. Abstr. Int., B) (TSS)

21827 BIOLOGICAL EFFECTS OF GAMMA RADIATION ON DIFFERENT CHARACTERS RELATED TO FITNESS COMPONENTS OF THE COTTON LEAF WORM SPODOPTERA LITTORALIS BOISD. Wakid, A. M.; Zaki, M. M.; El-Badry, E. A.; Souka, S. R. (Atomic Energy Establishment, Cairo). Isotop. Radiat. Res.; 3: 35-40(Jun 1970).

Egg-irradiation of the cotton leaf worm, Spodoptera littoralis Boisd, did not affect the incubation period or pupal duration, while larval duration was prolonged only at the relatively high doses. Adults produced from irradiated eggs had a shorter life span than the corresponding controls, especially when young eggs were considered. Fecundity of the produced adults was greatly reduced while their fertility was not affected. Larval irradiation did not affect the duration of immature stages except when the fifth larval instars were treated with relatively high doses. The pupal duration was prolonged and adult longevity was reduced. Lower doses had no, or a slight effect on adult longevity. Fecundity of the produced adults was lowered and viability of the deposited eggs was much reduced at all doses applied. Females were more sensitive to gamma radiation than males. (auth)

Vertebrates

Refer also to abstracts 21268, 21481, 21544, 21558, 21560, 21562, 21569, 21570, 21582, 21591, 21598–21600, 21602–21607, 21609, 21610, 21616, 21619, 21648, 21656, 21737, 21740, 21742, 21745–21747, 21780, and 21903.

21828 (AD-416196) INFLUENCE OF SPLENECTOMY ON THE PERIPHERAL BLOOD RESPONSE AND SURVIVAL OF ANIMALS SUBJECTED TO WHOLE-BODY X IRRADIATION. Klop-

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fenstein, K. A. (Army Medical Research Lab., Fort Knox, Ky.). 12 May 1963. 25p. (USAMRL-587). NTIS.

Splenectomy either before or immediately after exposure of dogs to 225 R resulted in less depression of the peripheral platelet and white cell values. When dogs were given doses approximating the LD sub 100-30, a tendency toward less hematologic depression was still noted but was much less evident than at the lower dose. Splenectomized dogs appeared to show slightly better survival following x irradiation but larger groups are needed to give statistical confirmation to this impression. Splenectomy of monkeys prior to receiving 600 R resulted in slightly less fall in hematocrit, but no significant differences in survival of platelet and white cell levels. Rabbits splenectomized prior to and LD sub 78 to 30 dose of 1000 R showed less depression of the peripheral blood elements and an increased-day survival, while splenectomy immediately after exposure resulted in neither. The favorable influence of splenectomy on radiation injury is considered most likely due to the removal of the normal inhibitory influence of the spleen on the bone marrow. (auth) (USGRDR)

21829 (AD-712054) EFFECTS OF 15,000 RADS PULSED GAMMA-NEUTRON RADIATION ON THE BEHAVIORAL PERFORMANCE OF MONKEYS (MACACA MULATTA). Young, R. W.; McFarland, W. L. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Jun 1970. 15p. (AFRRI-SR-70-7). NTIS.

Seven male monkeys trained to a visual discrimination task were exposed to a pulsed 15,000 rad midline tissue dose of γ-neutron radiation. Of these seven animals, five were unable to perform within 5 min postirradiation and remained in a state of total nonperformance until death. The two remaining animals experienced periods of severe performance decrement followed by a return of performance capability which approached the preirradiation value. This performance capability deteriorated rapidly at 58 and 88 minutes postirradiation in these two animals, after which time the subjects failed to perform until death. The median survival time for all animals was 1 hr and 18 min. (auth) (USGRDR)

21830 (ANL-7760(Pt.2), pp 18-21) A WAY TO PUT ERROR BARS ON POINTS OF ZERO INCIDENCE ON DOSE-RESPONSE CURVES. Marshall, J. H. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969-June 1970.

A recurring problem arises in presenting data on the dose response of cancer incidence due to radiation. In general one observes a certain number of tumors in each of several high dose groups, a diminishing number of tumors as the dose is decreased, and zero tumors in a number of low dose groups. It is easy to assign standard errors to the points with greater-than-zero observed tumor incidence, but a problem is presented by the very important groups that received some radiation but developed no tumors. If one considers the curve of tumor incidence as a function of dose, it is shown that in those groups in which zero tumors are observed in z cases, the standard error is $z/(z + 1)$ tumor. (auth)

21831 (BNWL-tr-63) EXPERIMENTAL STUDIES OF POST-IRRADIATIVE EXUDATIVE ENTEROPATHY IN ANIMALS. Witschi, H. P.; Huegli, H.; Barandun, S. Translated for Battelle-Northwest, Richland, Wash., from Schweiz. Med. Wochensch.; 92: No. 28, 866-71(1962). 12p. Dep. NTIS.

The pathogenesis of disorders in the permeability of intestinal epithelium induced by whole-body irradiation was studied in mice exposed to doses of 700 or 800 R x radiation and injected with ^{131}I-polyvinylpyrrolidone macromolecules having a molecular weight of 35,000 or 180,000, ^{131}I-triolein, and free ^{131}I. The activity of the dried cecal contents was measured during the following 10 days. The passage of all four test materials from the bloodstream through the intestinal lining followed roughly the same course, with maximum elimination observed on the 4th day. The results showed that large molecules pass through the intestinal wall following radiation injury. Implications of the findings in elucidating the pathogenicity of human post-irradiation disorders involving the loss of fats and proteins through the intestine are discussed. (C.H.)

21832 (BNWL-tr-64) PATHOGENESIS OF POSTIRRADIATIVE HYPOPROTEINEMIA. Witschi, H. P.; Barandun, S.; Cottier, H. Translated for Battelle-Northwest, Richland, Wash., from Schweiz. Med. Wochensch.; 92: No. 4, 104-10(1962). 17p. Dep. NTIS.

The excretion of ^{131}I-labeled polyvinylpyrrolidone (PVP) in the intestine was measured in adult Swiss albino mice 2, 4, 6, 8, or 10 days after short whole-body x-irradiation at doses of 500, 700, 800, or 900 R. Concomitant determinations of the serum total protein and the electrophoretically defined serum protein components were done. Compared to nonirradiated controls, irradiated animals showed an increased amount of ^{131}I-PVP in the intestinal content. Maximal values were found on the 4th day after exposure. The absolute values of serum total protein and albumin followed a reversed course. There seemed to be a correlation between radiation-induced enteric loss of plasma proteins and hypoproteinemia. The pathogenesis of radiation-induced dysproteinemia is discussed. (auth)

21833 (CEA-CONF-1720) STUDY OF INDUCED AND SPONTANEOUS CEREBRAL ELECTRICAL ACTIVITY IN ADULT RABBITS SUBJECTED TO WHOLE-BODY GAMMA IRRADIATION. Court, L.; Dufour, R.; Bassant, M. H.; Cassan, M.; Avargues, M.; Laget, P.; Hillion, H.; Le Chevallier, J.; Warme-Janville, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 11p. (In French). (CONF-700610-12). Dep. NTIS (U. S. Sales Only).

From 4th International Congress of Radiation Research, Evian, France.

In order to determine the role of the central nervous system in the development of the acute irradiation syndrome, the influence of whole-body γ irradiation from a 3,000 Ci ^{60}Co implant source varying between 250 and 850 rads on spontaneous and induced cerebral electrical activities, behavior, alertness level, and energy value of the electroencephalograph signal was studied on adult rabbits. The deteriorations observed correspond to: considerable changes in excitability consisting of successive inhibition and excitation phases; increased irritability; impossibility for structures such as the dorsal hippocampus, characterized by regular quasi-periodic activities during the waking period, to retain the basic frequencies at lethal doses; and abnormalities in the energy content of the electroencephalograph signals. (France)

21834 (CEA-CONF-1721) EFFECT OF GAMMA AND COMBINED GAMMA + NEUTRON IRRADIATION ON THE URINARY EXCRETION OF FREE AMINO ACIDS IN RABBITS IRRADIATED AT LETHAL DOSES. Marble, G.; Valle, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 8p. (In French). (CONF-700610-14). Dep. NTIS (U. S. Sales Only).

From 4th International Congress of Radiation Research, Evian, France.

In order to compare the urinary excretion of amino acids after pure gamma irradiation and after combined neutron + gamma irradiation, two groups of rabbits were subjected to these two types of irradiation. The first group was exposed to mixed γ and thermal neutrons emitted by uranium-235 nitrate critical assembly; the gamma dose absorbed was 300 rads. The second group received a total irradiation of 850 rads from a ^{60}Co source. The amino acids studied (taurine, cysteic acid, serine, threonine, glutamic acid, ethanolamine) show a difference between the effects of gamma and of gamma + neutron radiations. The enzyme systems appear to be attacked, the effect being less for gamma than for gamma + neutron irradiation. The systems most affected would be the dehydratases while the decarboxylases seem to be unchanged. (France)

21835 (CEA-CONF-1722) CHANGES IN THE BLOOD PRESSURE AND HEARTBEAT RATE IN RABBITS SUBJECTED TO WHOLE-BODY GAMMA IRRADIATION. Dufour, Raymond; Court, Louis; Avargues, Marcel; Bassant, Marie-Helene (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 22p. (In French). (CONF-700610-13). Dep. NTIS (U. S. Sales Only).

From 4th International Congress of Radiation Research, Evian, France.

Two groups of rabbits were subjected to a single whole-body irradiation by means of a ^{60}Co source at a dose rate of 14 rads per minute. The absorbed doses were 850 and 650 rads respectively. The results showed an increase in blood pressure followed by a rapid drop, then a partial restoration becoming more pronounced after 24 to 48 hours but never reaching the original level. At the same time the heartbeat rate showed a more or less marked increase during the first 24 hours, returning afterwards to the initial values. However the blood pressure fell more in animals exposed to 850 rads while the heartbeat was faster and returned to normal more quickly in those subjected to 650 rads. A study of the relationships between blood pressure and heart rhythm showed, in the case of irradiation, an early and relatively reversible attack on the regulation of the cardiovascular system. (France)

21836 (CONF-700816-(Vol.2), pp 697-720) TOXICOLOGY OF INHALED PLUTONIUM. Bair, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

In a series of experiments over the past 14 years, several plutonium compounds ($^{238}PuO_2$, $^{239}PuO_2$, $^{239}PuF_4$, and $^{239}Pu(NO_3)_4$) were administered to beagle dogs by inhalation to define the disposition of plutonium in the body and the resultant biological responses at the cellular and organ levels. All compounds showed a relatively long residence time in the lung. Plutonium translocated from the lung to other tissues accumulated principally in the tracheobronchial lymph nodes and to a lesser extent in liver, abdominal lymph nodes, and bone. After several years, plutonium in the tracheobronchial lymph nodes of dogs comprised about 40% of the total PuO_2 initially deposited in the alveolar lung. The biological effects observed in these studies included lymphopenia, cellular changes in lung and tracheobronchial lymph nodes, respiratory insufficiency, and pulmonary neoplasia, depending upon amount of plutonium inhaled. (auth)

21837 (LF-tr-47) EXPERIMENTAL PULMONARY CANCERS IN THE RAT FOLLOWING INHALATION OF RADON IN ASSOCIATION WITH NON-RADIOACTIVE DUSTS. Perraud, Roger; Chameaud, Jean; Masse, Roland; Lafuma, Jacque. Translated for Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex., from Compt. Rend., Ser. D; 270: 2594-5 (1970). 3p. Dep. NTIS.

A group of 11 rats, which were previously exposed to a single inhalation of stable cerium dust (1 mg resulting in the retention of 0.2 mg), were exposed within a period of 10 months to 108 seances of ^{222}Rn inhalation of five hrs duration each, resulting in a pulmonary radiation dose of about 3,000 Rad. Tumors appeared beginning with the 10th month. All of the animals were sacrificed before the 15th month. Eight showed malignant tumors of different stages of evolution: 6 more or less differentiated pulmonary epidermoidal carcinomas, 1 pulmonary fibrosarcoma, 1 epidermoidal carcinoma of the nostril with a quite suspicious pulmonary lesion; while 2 showed a pulmonary pseudo-adenoma and 1 seemed intact. (C.H.)

21838 (RT/BIO-(70)25) STUDY ON RADIOSENSITIVITY AND REPAIR OF RADIATION DAMAGE IN HAEMOPOIETIC STEM CELLS OF THE MOUSE. Siracusa, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 8 Apr 1970. 43p. (In Italian). Dep. NTIS (U. S. Sales Only).

A short review of some aspects of the radiobiology of mammalian hemopoietic stem cells is presented. Data are given from experiments on the γ- and x-radiosensitivity and recovery phenomena of mouse hemopoietic colony-forming cells derived from different sources. (auth)

21839 (TID-24270, pp E,25-49) OBSERVATIONS OF LIZARDS AND TREE FROGS IN AN IRRADIATED PUERTO RICAN FOREST. Turner, Frederick B.; Gist, Clayton S. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

From Tropical rain forest.

Populations of semiarboreal lizards (Anolis gundlachi and A. evermanni) and a tree frog, Eleutherodactylus portoricensis (the coqui), were studied at El Verde, Puerto Rico, for a year before the area was exposed to γ irradiation and again for 84 days following the experiment. Small thermoluminescent dosimeters were implanted beneath the skin of 100 A. gundlachi just before irradiation. Animals were killed by irradiation, and the density of all species was obviously reduced within 15 to 20 m of the source. (P.B.M.)

21840 (TID-24270, pp E,55-68) FACTORS AFFECTING ACTIVITY OF RAIN FOREST FROG POPULATIONS AS MEASURED BY ELECTRICAL RECORDING OF SOUND PRESSURE LEVELS. Drewry, George (Puerto Rico Nuclear Center, San Juan).

From Tropical rain forest.

The voice of Eleutherodactylus portoricensis was measured with a device designed and assembled to constantly record, from several locations within the forest, a 3 min integral of the fluctuating sound pressure level. During an interval when a filter that largely excluded sounds not made by E. portoricensis was added to the machine, the recorded sound levels increased with temperature and relative humidity. The unfiltered machine was used to document changes in forest sound during and after a period of strong γ irradiation and did detect differences attributable to radiation effects. (P.B.M.)

21841 (TID-24270, pp E,69-93) POPULATION DENSITY AND SEASONAL CHANGES OF THE AVIFAUNA IN A TROPICAL FOREST BEFORE AND AFTER GAMMA IRRADIATION. Recher, Harry F. (Princeton Univ., N. J. Dept. of Biology).

From Tropical rain forest.

From 1964 to 1966 bird populations were censused in 25 acres of lower montane rain forest at 450 m altitude at El Verde and in 9 acres of palm forest at 850 m altitude on Mt. Britton to the east. Fifteen species were found regularly, but over half were bananaquits (Coereba flaveola). At El Verde bird densities were 6.7 to 9.1 birds per acre and at Mt. Britton 5.8 to 7.7 birds per acre. Six species of nonresident warblers were counted, mainly in winter. Fewer territories were found close to the radiation source in 1965 after irradiation with γ rays. (auth)

21842 (TID-24270, pp E,169-81) STUDIES ON THE ROOF RAT (RATTUS RATTUS) IN THE EL VERDE FOREST. Weinbren, M. P.; Weinbren, B. M.; Jackson, W. B.; Villella, J. B. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Population field studies of the black roof rat, Rattus rattus, were made in the Radiation and South Control Centers at El Verde, both before and after radiation treatment of the area. The program of trap, mark, release, and retrap resulted in a total of 1821 captures, representing 618 different rats. Trapping efficiency for adult rats declined steadily for the first few months and then fluctuated around a relatively even level. A higher percent of immatures was found in summer. More rats were caught in areas in which there was less human activity. The home ranges of most rats (as indicated by sites of recapture) were relatively small, over 75% lying within a 20 m radius circle. Survival rate appeared to be low. Internal dosimeters were recovered with dose values similar to line of sight doses at these locations (0.8 to 206 R). Caged rats ate most of the rain forest fruits fed to them. (auth)

21843 RESPONSE OF THE SKIN OF SWINE TO INCREASING ABSORBED DOSES OF RADIATION FROM A THERMAL NEUTRON BEAM, A DEGRADED FISSION NEUTRON BEAM, AND THE $^{10}B(n,\alpha)^7Li$ REACTION. Archambeau, J. O.; Fairchild, R. G.; Brenneis, H. J. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 45: 145-65(Jan 1971).

Irradiation of 10-cm in diameter skin fields with increasing absorbed doses of the above radiations produced erythema, epilation, and a moist reaction that healed, healed partially, or did not heal. At low absorbed doses erythema and epilation occurred. At higher absorbed doses a moist reaction occurred at 18.2 ± 0.9, 20.0 ± 1.6, and 15.2 ± 0.7 days for the thermal neutron beam, fission neutron beam, and ^{10}B reaction, respectively. The moist reaction progressed to involve varying areas of the field by 29.3 ± 1.5, 27.4 ± 2.5, and 28.0 ± 1 days. If 20, 5, or 20% or less of the field was involved, complete healing occurred. If larger areas were involved only partial healing occurred. Healing was complete or maximal by 43.7 ± 1.6, 38.0 ± 2.5, and 45.3 ± 1.3 days. The time of occurrence was dose dependent for the fission neutron irradiation but not for the thermal neutron beam and for the $^{10}B(n,\alpha)^7Li$ reaction. The area of the field involved with the reaction was dose dependent. The absorbed dose at which 50% of the irradiated fields were not healed was 1469 ± 107, 944 ± 109, and about 1100 rads. The evolution of the moist reaction was similar to that produced following x ray. The time course was dose dependent following fission neutron beam irradiation, but not following the thermal neutron beam, $^{10}B(n,\alpha)^7Li$ reaction and x ray. The time course following the thermal neutron irradiation and the $^{10}B(n,\alpha)^7Li$ reaction was prolonged over that following x-ray. The dose at which 50% of the irradiated fields were not healed following x ray was 1.5, 2.7, and about 2 times larger than the radiations employed. (auth)

21844 RESPONSE OF THE SKIN OF SWINE TO INCREASING ABSORBED DOSES OF THE $^{10}B(n,\alpha)^7Li$ REACTION: HISTOLOGIC AND CYTOLOGIC CHANGES. Archambeau, J. O. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 45: 137-44(Jan 1971).

Sequential histologic changes and several cellular parameters were measured in two 10-cm diameter fields following the $^{10}B(n,\alpha)^7Li$ reaction. In one field receiving an estimated dose of 1250 rads a moist reaction was formed that failed to heal. In the second field receiving an estimated absorbed dose of 950 rads a moist reaction was formed which healed. During the first 20 days following irradiation there was a progressive loss of epidermal cells accompanied by an increase in the nuclear volume, a change in the mitotic index, and increase in capillary diameters. In the field that did not heal the increase in nuclear volume was fivefold, the mitotic index went to zero and remained there. In the case of the field that healed the increase in nuclear volume was fourfold at 21 days. During the 1st week,following irradiation there was a wave of abnormal mitoses, followed by reduction of the mitotic index to zero. During the

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interval from 20 to 27 days the epidermis was regenerated in the field that healed. The nuclear volume and mitotic index were at control levels at this time; however, capilllary diameters continued to increase and were 2.5 times the control level at 27 days. (auth)

21845 EFFECTS OF RADIATION ON ESTUARINE ORGANISMS. Angelovic, J. W.; Engel, D. W. Mar. Pollut. Bull.; 1: 103-5(Jul 1970).

The effects of ionizing radiations, present either as a single acute dose or as continuous low level irradiation on the viability of specific marine and estuarine organisms was investigated. Previous work on radiation sensitivities and the median lethal dose, LD_{50}, is discussed. LD_{50} values of ^{60}Co radiation for Fundulus heteroclitus at different salinities, temperatures and times after irradiation are tabulated. The effects of radiation, salinity, and temperature on the survival and growth of brine shrimp and Fundulus heteroclitus were also investigated. Haematopoietic systems are considered and the possible direction of future research indicated. (UK)

21846 CHANGES IN ARTERIAL PRESSURE AND EXTERNAL RESPIRATION OF ANIMALS WHEN SUBJECTED TO AN ULTRA-HIGH FREQUENCY ELECTROMAGNETIC FIELD (MICROWAVE). Komarova, L. A. Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 33: 503-6(Nov-Dec 1968). (In Russian).

The effects of ultra-high frequency (microwaves electromagnetic fields on certain functions in animals were studied using anesthetized cats exposed to the Beam-58 apparatus with frequency oscillations 2375 mgc, wave length 12.6 cm for 10 min at 5 to 6 cm distance and the current density 0.4 and 0.13 V/cm^2 (with the input power of 6 V and output 20 V). Arterial pressure, pressor reflexes, and external respiration were observed after various doses of microwaves to the dorsal surface of the head, stomach area, and front throat surface. (R.V.J.)

21847 STUDY OF BLOOD SERUM AND MYOCARDIAL PROTEINS IN ANIMALS FOLLOWING EXPOSURE TO MICROWAVES. Grigor'yan, D. G. Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 34: 52-5(1969). (In Russian).

The influence of microwaves on metabolic changes in blood protein and heart muscles was studied using 25 female rats weighing 200 to 230 g. Twenty-five days following the exposure to microwaves (pulse position modulation (ppM) 0.006 and 0.04 V/cm^2) the content of albumin in the blood serum was considerably reduced and the content of β- and γ-globulin increased. The dose of ppM – 0.006 V/cm^2 microwaves had a negligible effect on the ratio of protein fractions in heart muscle, while ppM 0.04 V/cm^2 produced more pronounced effects. (R.V.J.)

21848 IMPLANTABLE NUCLEAR POWER SOURCES FOR ARTIFICIAL ORGANS: PRELIMINARY PATHOLOGIC EFFECTS. II. Sandberg, Glenn W.; Molokhia, Farouk A.; Huffman, Fred N.; Norman, John C. (Boston City Hospital. Thermo Electron Research and Development Center, Waltham, Mass.). Surg. Forum; 21: 198-200(1970).

From 26th Annual Sessions of the Forum on Fundamental Surgical Problems, 56th Clinical Congress of the American College of Surgeons, Chicago, Ill. See CONF-701014.

Implantable nuclear power sources for artificial organs were investigated in relation to their pathological effects on animals. Long-term monitoring studies of animals bearing 16 to 24 thermal watt (33 to 50 g) ^{238}Pu sources or radiation equivalent sources (^{90}Sr-^{241}Am/Be) with a combined photon and neutron surface dose rate of approximately 10^3 mrem/hr are being conducted. Fourteen months after thoracic implantation, the first detailed pathologic examinations showed no gross or microscopic changes in any of 30 organs examined. Within the observed time limits and continuing, these intracorporeal nuclear power sources were well tolerated. However, further long-term studies of greater statistical significance are mandatory. (E.E.H.)

21849 ACTION OF X RAYS ON THE UNFORMED LIMBS OF GREEN LIZARD EMBRYOS. Vasse, Janvier (Institut Pasteur, Paris). Compt. Rend., Ser. D: 271: 2193-6(9 Dec 1970). (In French).

Whole-body x irradiation of green lizard (lacerta viridis) embryos at a dose of 4300 R caused abnormalities in the limbs, especially when administered at an early stage of development: from the 8th to the 15th day, disturbed differentiation of the skeleton forming tissue, abnormal patella, toes fewer than normal or absent. When the irradiation is carried out later four or five toes are formed, more or less joined together. (auth) (France)

21850 GENERAL EFFECTS OF X RAYS ON GREEN LIZARD EMBRYOS. Pieau, Claude; Vasse, Janvier (Institut Pasteur, Sannois, France). Compt. Rend., Ser. D: 271: 2023-6(30 Nov 1970). (In French).

Lacerta viridis embryos were x irradiated with doses of 1,200, 1,600, and 4,300 R from the 8th until the 21st day of incubation. They survived these doses, but it was found that the number of anomalies produced increased with the magnitude of the dose. These anomalies concerned: growth, external morphology, and internal organs. (auth) (France)

21851 ALTERATION OF THE MEGAKARYOCYTIC-THROMBOCYTIC APPARATUS FOLLOWING PROLONGED FRACTIONATED IRRADIATION. Babushkina, A. G.; Muksinova, K. N. (Inst. of Biophysics, Moscow). Med. Radiol.; 6: No. 1, 36-40 (Jan 1971). (In Russian).

Data are presented on alteration of thrombolesis in Wistar rats following daily fractionated γ irradiation at a dose of 50 R. A reduction of the absolute peripheral thrombocyte content and bone marrow megakaryocytes in irradiated animals, and also shifts in the thrombocytic and megakaryocytic formula were observed. These changes intensified with increase of the total dose of irradiation. By means of autoradiography with ^3H-thymidine it was established that processes of endoreplication of megakaryocyte nuclei in irradiated animals were not disturbed, whereas the maturation of these cells were significantly delayed. (auth)

21852 PRENATAL MORTALITY CAUSED BY THE IRRADIATION OF SPERMATOZOA. Leonard, A. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Compt. Rend. Soc. Biol.; 164: 903-7(1 Dec 1970). (In French).

The first stages of development of oocytes fertilized by x-irradiated spermatozoa were studied. In reference animals the loss is found to be 22% before and 6% after implantation; these values become 27 and 21% respectively after administration of 400 R to the males, and 47 and 28% after 1200 R. Examination of the first stages of development of the embryos shows that this increased prenatal mortality rate is linked with the presence of abnormalities, the most frequent of which is that of micronuclei. (France)

21853 MORPHOLOGICAL CHANGES IN THE CEREBELLUM OF IRRADIATED GUINEA PIGS AFTER TRANSPLANTATION OF MARROW. Bregadze, M. A. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 59: 465-8(Aug 1970). (In Russian).

A study was made of morphological changes of the glial (astroglia) and nerve (Purkinje) cells in the cerebellum of irradiated animals after transplantation of bone marrow. Transplantation was found to reduce the lesion of glial and nerve cells. (auth)

21854 INCIDENCE OF MATING IN X-IRRADIATED FEMALE RATS. Hahn, Eric W.; Ward, William F. (Univ. of Rochester, N. Y.). J. Reprod. Fert.; 20: 151-4(1969).

Mating (psychic estrous) resulting in term pregnancy (indicating physiological estrous) was used to characterize the estrus cycle of an initially synchronous population of virgin female rats for a period of 30 days following exposure to 250 or 500 R single dose x radiation. Results indicated that while 500 R doses influenced the particular day on which the animals mated, neither dose of radiation affected the total percentage of animals mating during the first 30 days after metestrous. There appeared to be no dissociation of psychic and physiological estrus in the irradiated animals. (E.E.H.)

21855 EFFECTS OF X RAYS ON N. DUBIUS INFECTED MICE. Ragin, James Frederick. Fort Collins, Colo.; Colorado State Univ. (1970). 109p. University Microfilms Order No. 70-20,021.

Thesis.

Two experiments were conducted on twelve different inbred strains of mice. In Experiment I when mice were infected with Nematospiroides dubius L_3 larvae, it was determined that 400 ± 50 L_3 larvae were not lethal for all mice. Weight changes and lethal effects were observed over a period of thirty days. The mean percentage of mice that succumbed to N. dubius L_3 larvae varied according to their genetic strain. When x irradiation of the whole-body was effected in Experiment II (300 R and 350 ± 50 L_3 larvae) the results showed that mice irradiated prior to infection by N. dubius larvae responded similarly to mice infected with nematodes but not irradiated. When all responses except weight changes were considered, the irradiated and infected mice responded with greater intensity. Irradiation before infection with nematodes caused an increase in the number of mice that died and decreased the number of days fatally affected mice lived post-nematode infection. Indications are that the dose of whole-body irradiation (300 R) reduced the effective-

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ness of the immune mechanism but no tests were run to prove this conclusion. The infectious larvae also opened the way for intestinal invasion of bacteria. The combination of damage from irradiation and that caused by L_3 larvae resulted in more extensive damage than either factor acting separately. The percentage killed of irradiated mice infected with L_3 N. dubius larvae was the most significant evidence of the combination of irradiation and nematode infection. It is postulated that the larger the infectious nematodes, the more damage occurs in the intestine and the greater the ease of infection by intestinal bacteria in irradiated mice. (Diss. Abstr. Int., B)

21856 EFFECTS OF GAMMA RADIATION ON BEHAVIOR MAINTAINED BY INTRACRANIAL STIMULATION AND FOOD. Lewis, Barbara Ann. Philadelphia; Temple Univ. (1970). 117p. University Microfilms Order No. 70-19,756.

Thesis.

The effects of a supralethal dose of γ radiation on behavior maintained by two positive reinforcers, intracranial stimulation, and food were compared. It had been reported that appetitively-motivated behavior, such as that maintained by food or water, rapidly declined following irradiation, supposedly due to radiation malaise or gastrointestinal disturbances. Aversively-motivated behavior, however, such as shock avoidance, stayed at nearly control levels, for long periods, after even massive doses of radiation. It had not been determined whether radiation depressed all positively-motivated behavior. Four groups of rats were used as Ss. They were trained to bar-press in an operant conditioning apparatus on a variable interval schedule of one min., two groups for intracranial stimulation (ICS) and two groups for food pellets. The ICS groups received a 1-sec stimulation of 300 μA peak to peak sine wave and the food groups, 45 mg. pellets. All Ss were trained to work on a 24-hr schedule of 15 min. working time out of each hour. Onset of working time was signalled by a white stimulus light and white noise which remained on during the work period and went off with the termination of the work period. At the end of five days of this training, one ICS group and one food group were irradiated with 5,000 rads and the other two groups, sham-irradiated. Immediately following exposure (or sham-exposure) all groups were returned to the test chambers where they continued on the same work schedule until the demise of the irradiated Ss. The data were analyzed in a $2 \times 2 \times 13$ factorial design with repeated measures on the third factor. The results suggest that radiation selectively affects only those behaviors maintained by positive reinforcers concerned with gastric functions. ICS appears to be a powerful positive reinforcer, capable of maintaining behavior after lethal doses or radiation, at least for the parameters investigated in this experiment. It was suggested further that the response decrement in the food-irradiates may not have been due to a loss of the reinforcing properties of food, due to anorexia resulting from gastric damage, but that painful irritation of the gastrointestinal system may have prevented Ss from eating. (Diss. Abstr. Int., B)

21857 DOSE RESPONSE CURVE FOR RADIATION-INDUCED LIFE SHORTENING. Yuhas, John M. (Jackson Lab., Bar Harbor, Me.). Contracts AT(30-1)-3314; DA-49-193-MD-2289. J. Gerontol.; 24: 451-6(Oct 1969).

The dose response curve for radioinduced life shortening was studied in two inbred strains of mice, A/J and C57BL/6J (total 2,374 mice). The experimentally observable area of the curve that can be studied was expanded through use of a radioprotective agent, WR-2721 [S-2-(3-aminopropylamino)ethylphosphorothioic acid] which protects against acute death more efficiently than it protects against the life shortening effects of radiation. While the exact protection that this agent offered against life shortening was impossible to quantitate, the maximum and minimum protection that it offered can be estimated. Whether it is assumed that the actual protection this agent offers is equal to the theoretical maximum or the theoretical minimum, the shape of the dose response curve for radioinduced life shortening was found to be dependent on the mouse strain studied. Life shortening is a linear function of radiation dose in the A/J mice in the low dose range and plateaus in the high dose range. In the C57BL/6J life shortening was a curvilinear function of radiation dose over the entire dose range, and life shortening values of 90% can be obtained with appropriate combinations of WR-2721 and x rays. It was concluded that there is no single dose response curve for radioinduced life shortening that is universally applicable to all mice. (auth)

21858 EFFECT OF RADIATION ON THE REPRODUCTIVE SYSTEM OF THE INDIAN CATFISH, HETEROPNEUSTES FOSSILIS BLOCH. I. ANNUAL CYCLE IN THE DEVELOPMENT OF OVARIAN EGGS. Srivastava, P. N.; Rathi, S. K. (Univ. of Rajasthan, Jaipur, India). Acta Anat.; 75: 114-25(1970).

Since the growing oocytes provide favorable and interesting material for the analysis of many problems pertaining to radiation injury, the development of the ovarian eggs was studied. Results reported for investigations on oogenesis in the Indian catfish, Heteropneustes fossilis, which will provide a basis for the assessment of the radiopathological changes occurring in the irradiated ovaries, to be reported subsequently. (auth)

21859 EFFECT OF RADIATION ON LECITHIN METABOLISM, SURFACE ACTIVITY, AND COMPLIANCE OF RAT LUNG. Naimark, A.; Newman, D.; Bowden, D. H. (Univ. of Manitoba, Winnipeg). Can. J. Physiol. Pharmacol.; 48: 685-94(Oct 1970).

The effects of ionizing radiation on lecithin metabolism, surface activity, and compliance of the lung were studied in rats. At intervals of 1 to 4 months after irradiation of the right hemithorax (3000 R, single dose), exposed lungs were compared with contralateral shielded lungs and with the right lungs of nonirradiated control rats. Four months after exposure, irradiated lungs did not differ in DNA content from controls but exhibited decreased lecithin content, depressed incorporation of palmitate-1-^{14}C into lecithin in vitro, and a decrease in the percentage of palmitic acid in the lecithin fraction. Changes in other phospholipids were qualitatively similar. The stability of bubbles expressed from the cut surface of irradiated lungs decreased progressively with time, indicating impaired surface activity of the lung-lining layer. This was associated with a progressive decrease in compliance of the lung. Electron microscopy revealed no qualitative changes in the alveolar epithelial cells. Morphologic evidence of injury was most prominent in the capillaries and could be detected before changes in phospholipid content, surface activity, and compliance. The studies indicated that irradiation of the lung is associated with alterations in lecithin content, in surface activity, and in compliance of the lung, and suggest that such changes are secondary to endothelial damage rather than a reflection of a primary effect on surface activity. (auth) (Canada)

21860 EFFICIENCY OF ANTIBIOTICS UNDER CONDITIONS OF PROLONGED γ IRRADIATION OF LOW INTENSITY. Zelyakova, D. I. Antibiotiki; 15: 519-22(1970). (In Russian).

The efficiency of antibiotic therapy under total conditions of prolonged external γ-irradiation of rats at a dose of 0.24 to 0.28 R/min. (total dose up to 1600, 1860 and 2000 R) was studied. It was found that efficiency of the antibiotics depended on the total dose of γ-irradiation. High efficiency of the antibiotic therapy was observed within the doses inducing death of 70 to 90 per cent of the control animals. Under such irradiations of streptomycin, penicillin and levomycetin were almost as effective. The therapeutic effect of oletetrin under conditions of irradiation with lethal doses significantly decreased (80 per cent of deaths). Treatment begun during the first days of the irradiation was most effective. The results indicate the necessity of including antibiotics in therapy of acute disease, induced by external γ-irradiation. (auth)

21861 EFFECT OF IONIZING RADIATIONS ON DEVELOPMENT OF LYMPHATIC COLLATERALS. Prives, M. G.; Drozdova, A. V.; Khudaiberdyev, R. I. (Pavlov First Medical Inst., Leningrad. Medical Inst., Tashkent). Arkh. Anat., Gistol. Embriol.; 59: No. 12, 95-104(Dec 1970). (In Russian).

Analysis disclosed a number of common features in development of collaterals after local (x-ray), mixed (neutron-gamma), or general (gamma) irradiation. In contrast to usual patterns of development of collateral paths of lymph drainage, the following peculiarities are found to occur after exposure to one of the above three kinds of radiation. At stage I appearance of collaterals is delayed. At stage II anastomoses between interrupted vessels fail to develop and the collaterals grow slowly. At stage III a considerable amount of collateral paths of lymph drainage is found to be functioning, irrespective of the presence or absence of anastomoses between interrupted paths. Lymph drainage is directed to several groups of lymph nodes that were not previously considered as regional nodes. Appearance of large numbers of collaterals after, local exposure also takes place in the contralateral limb. (auth)

21862 IRRADIATION DOSE AND LATENCY TIME ASSOCIATED WITH THE APPEARANCE OF CATARACTS IN RABBITS. THE RELATIVE BIOLOGICAL EFFECTIVENESS OF 14 MeV NEUTRONS. Haye, C.; Legeay, G.; Bazin, J. P.; Quechon, H. (Institut du Radium, Paris). Ann. Ocul. (Paris): 203: 749-67(1970). (In French).

The relative biological effectiveness of 14 MeV neutrons for producing cataracts in rabbits was studied. Well established clinical stages corresponding to lens opacification criteria were adopted; this enabled the lens response function to be studied with respect to the absorbed dose and the mean incidence time

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before the various cataract stages appeared. The graphs obtained indicated an induction threshold or incidence time and RBE values could be determined, as a function of the stage by comparison with reference γ rays, for the intervals in which the incidence time was a function of dose. (auth) (France)

21863 ELECTRON MICROSCOPIC STUDIES ON EXPERIMENTAL MASUGI NEPHRITIS IN RABBITS PRIOR TO AND AFTER EXPOSURE TO X-RAYS. II. COMMUNICATION. Metev, M.; Petrova, El. Voenno Med. Delo; 22: No. 6, 27-32 (1967). (In Bulgarian).

The electron microscopic changes occurring in rabbits with Masugi nephritis after exposure to 600 R.x radiation were studied and correlated with the findings in rabbits with non-irradiated nephritis, in exposed rabbits without nephritis, and in normal rabbit kidneys. The results obtained show that total exposure of rabbits to the above dose applied in animals with experimental Masugi nephritis on the 12th day after injecting nephrotoxic serum, aggravates the lesions in the basement membrane, the glomerular endothelia, and especially the tubular cells. On the 26th day after injecting nephrotoxic serum (acute stage) there occurs almost complete cellular destruction. Irradiation in the subchronic stage (on the 30th day after injecting nephrotoxic serum) compared with irradiation in the acute stage gives rise to milder changes primarily involving the nuclei of all the cells and to a certain extent the cytoplasm of the tubular cells. It is suggested that these changes result from blocking of DNA metabolism induced by ionizing radiation and from inactivation of the enzymatic systems in the tubular cells which are rich in enzymes. (Abstr. Bulg. Sci. Med. Lit.)

21864 EFFECT OF GAMMA RADIATION ON THE PRIMATE CARDIOVASCULAR SYSTEM. Myers, James Hurley. Memphis; Univ. of Tennessee (1969). 159p. University Microfilms Order No. 70-9960.

Thesis.

The role of the cardiovascular system in the acute radiation sequelae has been neglected, possibly because circulatory deterioration has been masked by the cardiovascular reserve, and thus, not a part of the more prominent symptomatology. Studies were made from a cardiovascular standpoint, on the impact imposed by acute, whole-body irradiation on the capacity of a large, sub-human primate (baboon) to respond to a severe, but sublethal cardiovascular challenge. Thirty baboons were separated into five different dose-groups and treated as follows: one group was sham-irradiated and the remaining four groups acutely exposed to either 250, 500, 750, or 1000 R whole-body γ irradiation (35 R per minute). The cardiovascular challenge was induced at 2, 48, and 168 hours post-irradiation. Each challenge lasted approximately ten minutes and consisted of the rapid withdrawal and reinfusion of an estimated 43 per cent (25 ml/kg) of the baboon's blood volume. The pre-irradiation assessment of cardiovascular function, measured hemodynamically, volumetrically, and hematologically, was used to compare to post-irradiation measurements made before and 30 minutes after each cardiovascular challenge. A moderate to marked reduction in the mean arterial blood pressure of acutely irradiated baboons was noted two hours after irradiation. A concomitant decrease in the total peripheral resistance, particularly of the 500 R and 1000 R groups, suggested that changes in peripheral vascular tone probably were responsible for an initial transitory disruption of cardiovascular function. Assessment of hemodynamic function prior to the 48-hour challenge indicated that, even after 1000 R, baboons were free of detectable circulatory disturbances; whereas, the 168-hour post-irradiation measurements provided evidence of highly variable and considerably different values for animals of the 750 R and 1000 R groups. From these results it is suggested that by seven post-irradiation days baboons within the higher dose-groups may very well exhibit real trends in aberrant cardiovascular function, but their importance has been masked by the individual variability of a small population. The possible mechanism for the reduced adaptive response of acutely irradiated baboons can be suggested from several radiation-induced disturbances. From the results of the present investigation, it would appear that cardiac weakening, a deteriorating or depleted pituitary-adrenal system, tissue hypoxia, and leukopenia compromised the capacity of acutely irradiated baboons to respond to the added insult. It is suggested, therefore, that the extent of injury inflicted by whole-body irradiation depends greatly on the animal's physiologic reserve the depth of which may in fact be reflected in the post-irradiation variability or stability of cardiovascular system. (Diss. Abstr. Int., B)

21865 POSTNATAL DEVELOPMENT AND GENETIC LESION OF MICE TREATED WITH ^{131}I DURING THE FOETAL PERIOD. Bajrakova, A. K. Rentgenol. Radiol.; 8: No. 1, 36-41(1969). (In Bulgarian).

Eighty-eight pregnant mice of "H" line, weighing averagely 38 g, were studied. Thirty of them were treated with ^{131}I per os on the 16th day after conception. The remaining mice, used as controls, were receiving, at the same time, an equal quantity of water. A high rate of postnatal mortality was provoked by 120 μCi ^{131}I. General changes in growth of the progeny were also observed. There was a reduction in size of the litters and genetic changes were observed. (Abst. Bulg. Sci. Med. Lit)

21866 EFFECT OF INTERFERON ON THE COURSE OF SPONTANEOUS AND RADIATION-INDUCED RENAL LESIONS IN THE RF/Un MOUSE. Guttman, P. H.; Davis, W. C.; Fudenberg, H. H.; Merigan, T. C. (Univ. of California, San Francisco. Stanford Univ., Palo Alto, Calif.). Contracts Nonr-3656(12); AT(11-1)-34. Vox Sang.; 17: 279-88(Oct 1969).

A spontaneous form of progressive intercapillary glomerulosclerosis (IGS) develops in RF/Un mice in early life and is accelerated by neonatal irradiation. The lesions are similar to those seen in mice with viral infections and may be of viral origin. In the present study, daily injection of the antiviral agent interferon appeared to retard the course of both spontaneous and radiation-induced IGS in RF/Un mice. In addition, the occurrence of the lesions was independent of the occurrence of myeloid leukemia, suggesting that if IGS is viral mediated, the virus is different from the agent responsible for the high incidence of myeloid leukemia in mice of the RF/Un strain. (auth)

21867 ^{60}Co CUMULATIVE AND/OR SINGLE DOSE RADIATION EFFECTS ON THE PERIPHERAL NERVES FOLLOWING WHOLE-BODY IRRADIATION. Nakas, M.; Leicher, Z.; Jamakosmanovic, A. Folia Med. Fac. Med. Univ. Saraeviensis; 4: 125-30(1969).

Cobalt-60 whole-body irradiation in a total dose of 20.000 R, whether applied singly or cumulatively, fails to affect the absolute value of the amplitude of the frog sciatic action potential. In the course of the post-radiation period the survival time of irradiated nerves is reduced by 25 to 30% compared with the controls, except in the case of single dose irradiation on the second day of the period, where it is significantly prolonged. Cumulative doses of irradiation cause evident variations in the excitability of the peripheral nerves. (Bull. Sci. Sect. A.)

21868 ANAEMIA IN BURSECTOMISED IRRADIATED CHICKENS. Aln, G. V.; Peterson, R. D. A. (Univ. of Chicago). Nature (London); 229: 201-2(15 Jan 1971).

It was found that a significant percentage of bursectomised 600 R x-irradiated chickens developed a severe anaemia. The haematocrit, the haemoglobin concentration, and the erythrocyte count were all significantly depressed. Examination of bone marrow smears showed that all the chickens had cell rich bone marrow. These chickens also had significantly fewer mature erythrocytes. A possible cause of the anaemia was viral or bacterial infections facilitated by immune deficiency, although an autoimmune basis could not be excluded. Another possibility was a direct involvement of the bursa of Fabricius, by means of cells and/or humoral factors in erythropoiesis. (UK)

21869 EXPERIMENTAL STUDY OF AEROSOL TULAREMIC INFECTION IN X-IRRADIATED RATS. Samnaliev, M. Voenno Med. Delo; 24: No. 2, 45-50(1969). (In Bulgarian).

White rats, previously irradiated with 450 or 650 roentgens, were infected with tularemic bacteria by means of aerosolization. This caused the development of an infection with primary localization in the lungs. Tularemic bacteria were discovered in the lungs, tracheobronchial lymph nodes, spleen and blood. The organisms continued to multiply in all rats until the fourth day after which there was a decline in growth in the control animals. In the irradiated animals the organisms continued to multiply until death. Resistance to tularemia was greatly reduced by x radiation. (Abstr. Bulg. Sci. Med. Lit.)

21870 ULTRAVIOLET CARCINOGENESIS. Epstein, John H. (Univ. of California, San Francisco). Photophysiol. Curr. Top.; 5: 235-73(1970).

The literature on the following aspects of ultraviolet carcinogenesis is reviewed: carcinogenic action spectrum; experimental model and tumor types; tumor development; physical and chemical influences on ultraviolet light carcinogenesis; acute reactions to ultraviolet light; and human skin cancer formation. (H.L.W.)

21871 TOXICOLOGY OF RADIOACTIVE SUBSTANCES. VOLUME 5. ^{65}Zn. Letavet, A. A.; Kurlyandskaya, E. B. (eds.).

Elmsford, N. Y.; Pergamon Publishing Company (1970). 191p. $11.50.

Translated from the Russian by A. Crozy.

Separate abstracts were prepared for the 18 papers included in the book. (F.M.M.)

For abstracts of individual papers see: 21570–21573, 21606, 21607, 21872–21883.

21872 BIOELECTRICAL ACTIVITY OF THE CEREBRAL CORTEX IN RABBITS IN CONDITIONS OF PROLONGED ADMINISTRATION OF RADIOACTIVE ZINC. Ovakimov, V. G. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 40-5(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 40-5(1965).

Zinc-65 was administered orally to rabbits and investigations of the electrocorticograms were made. Comparisons of background bioelectric activity in test animals with electrocorticograms for the same rabbits at different times of burdening showed no significant changes. The influence of photostimulation on the frequency range of repetition of cortical rhythms was also studied in animals receiving radiozinc. (F.M.M.)

21873 EFFECT OF PROLONGED INTERNAL IRRADIATION OF RABBITS WITH $^{65}ZnCl_2$ ON THE FUNCTIONAL STATE OF THE HEART. Ovakimov, V. G.; Bibikhin, L. M. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 46-59(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 46-59(1965).

In test rabbits with 4 to 5 months' burdening with radiozinc in an amount of 10 μCi/kg daily a rise in the sensitivity of the adrenoreactive systems of the myocardium and an absence of an appreciable difference in the intensity of reflex bradycardia as compared with controls were shown. In the test animals following 12 months burdening with radiozinc in an amount of 1.0 and 10 μCi/kg the sensitivity of the adrenoreactive systems of the myocardium was reduced with an increase, as compared with the controls, in reflex bradycardia. Study of the olfactory cardiac reflex on inspiration of ammonia gas in animals subject to chronic oral administration of radiozinc (1.0 and 10 μCi/kg) indicated an increase in them of the intensity and duration of reflex bradycardia. In test animals at various times during the 12 months' burdening with radiozinc in an amount of 0.1 μCi/kg no appreciable changes were found in the intensity of reflex bradycardia (experiments with adrenaline and ammonia), nor in the sensitivity of the adrenoreactive systems of the myocardium. (auth)

21874 HAEMOPOIESIS FOLLOWING PROLONGED INTAKE OF RADIOACTIVE ZINC. Beloborodova, N. L.; Red'kina, E. K. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 60-74 (1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 60-74(1965).

Investigation of haemopoiesis in rabbits of four groups given daily for 12 months ^{65}Zn with stable carrier (1 and 10 μCi/kg weight) or stable zinc alone (in an amount corresponding to 10 μCi/kg ^{65}Zn) and also control animals revealed a distinctive character of the influence on the hemopoiesis of ^{65}Zn as compared with its stable isotope. Changes in erythropoiesis (reticulopenia in the bone marrow, change in size and shape of erythrocytes in the blood) were observed both on administration of 10 μCi/kg ^{65}Zn and stable isotope. However, radioactive zinc caused a fall in the amount of hemoglobin while the stable form raised it. Administration of 1 μCi/kg ^{65}Zn produced no significant changes. On administration of 10 μCi/kg ^{65}Zn signs of depression of lymphopoiesis were observed in the form of gradually developing absolute lymphopenia. Administration of 1 μCi/kg did not cause change in the number of lymphocytes in the blood. In animals receiving stable zinc temporary absolute lymphocytosis was observed at the start of the experiment. The changes in neutropoiesis (disturbance in maturation in the bone marrow, a shift to the left in the blood) were distinctly marked even on administration of 1 μCi/kg ^{65}Zn that indicates raised sensitivity of the granulocytic series of the bone marrow to radiozinc. The effect of the stable zinc isotope was considerably weaker. Comparison of the changes in the morphological composition of the bone marrow and the peripheral blood suggests that on prolonged administration of stable and particularly radioactive zinc (10 μCi/kg) there is a gradual increase in the permeability of the bone marrow barrier in relation to neutrophils and also reticulocytes. No changes in thrombocytopoiesis were observed in any of the groups. (auth)

21875 ASPECTS OF HAEMOPOIESIS FOLLOWING CHRONIC INTAKE OF RADIOZINC IN A DOSE OF 0.1 μCi/kg. Red'kina, E. K. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 75-83(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 75-83(1965).

Administration of a dose of 0.1 μCi/kg ^{65}Zn to rabbits for 15 months produced change in erythro- and leucopoiesis. After 1 to 3 months some depression of erythropoiesis and signs of stimulation of the granulocytic portion of the bone marrow were observed. After 6 to 12 months activation of total bone marrow hemopoiesis was obvious. There was hyperplasia of the red and white series of the bone marrow and marked reticulocytosis in the bone marrow. In the peripheral blood persistent reticulocytosis and an increase in the number of rod nuclear neutrophils was observed. After 13 to 15 months signs of disturbance in maturation of erythroblasts at the stage of the basophilic forms and neutrophils at the stage of the rod nuclear types appeared. In the peripheral blood throughout the observation period an increase in the number of lymphocytes, neutrophils and basophils was periodically noted. (auth)

21876 HAEMOPOIESIS AND MORPHOLOGICAL CHANGES IN THE ORGANS OF RABBITS FOLLOWING PROLONGED ADMINISTRATION OF ^{65}Zn WITHOUT CARRIER. Beloborodova, N. L.; Gaidova, E. S.; Red'kina, E. K. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 84-9(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 84-9(1965).

Following daily administration to rabbits of 1 μCi/kg ^{65}Zn for 4 months without carrier, the animals remained virtually normal. The greatest changes were found in the organs of hemopoiesis. In the bone marrow there was a gradual increase in the relative and absolute numbers of the young cells of the neutrophil series. The absolute number of all neutrophils also increased. Intensified release into the blood of rod nuclear neutrophils was observed that produced a shift to the left in the nuclear formula of the neutrophils. The changes in erythropoiesis were slight and reflected a temporary acceleration of maturation of the protoplasm of the erythroblasts. Depression of lymphopoiesis (lymphopenia, morphological changes of the lymphoid tissue) was not found. However, in the initial period of the experiment some qualitative changes primarily of a degenerative character were noticed in the lymphocytes of the peripheral blood. In the lungs and splenic pulp foci of extramedullary hemopoiesis were found. In a number of internal organs together with moderate degenerative changes there were signs of stimulation of the reticulo-endothelial system. (auth)

21877 CERTAIN CHANGES IN CARBOHYDRATE METABOLISM IN RABBITS FOLLOWING CHRONIC ADMINISTRATION OF ^{65}Zn. Orlyanskaya, R. L. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 90-5(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 90-5(1965).

No significant changes were seen in the blood sugar levels in rabbits on prolonged administration of ^{65}Zn (with carrier) in doses of 10, 1, and 0.1 μCi/kg and also ^{65}Zn without carrier in a dose of 1 μCi/kg. Absence of changes in the blood sugar levels was also noted on administration of stable Zn in a dose of 0.1 mg/kg. After 15 months' exposure a significant difference was found in the course of the glycemia curves in the group of animals receiving 10 μCi/kg ^{65}Zn with carrier and only stable Zn in a dose of 0.1 mg/kg. In this period stable Zn elevated the glycemia curves for the rabbits after a glucose load while radiozinc lowered them. (auth)

21878 CHANGE IN THE PROTEIN FRACTIONS OF RABBIT SERUM ON CHRONIC ADMINISTRATION OF ^{65}Zn. Orlyanskaya, R. L. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 96-105(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 96-105(1965).

No significant changes were found in the total serum protein of rabbits given various doses of ^{65}Zn. No significant changes were found in the content of the serum protein fractions in rabbits receiving in 5 months ^{65}Zn in a dose of 1.0 μCi/kg (without carrier) and also receiving in 9 months ^{65}Zn at dose of 0.1 μCi/kg with carrier. A significant fall was established in the albumin fraction in rabbits given ^{65}Zn (with carrier) in a dose of 10.0 μCi/kg and also only stable zinc in a dose of 0.1 mg/kg. The peak of these changes was seen in the ninth month of the experiment. For the group receiving ^{65}Zn in a dose of 10.0 μCi/kg with carrier and that receiving only stable zinc in a dose of 0.1 mg/kg a significant increase was noted in the α-, β-, and γ-globulin fractions in the ninth month of the experiment. By the twelfth month of the experiment all the serum protein fractions were back to normal, that indicates the phasic pattern of the changes noted. The direction of the effects of ^{65}Zn and stable zinc was the same. Radio-

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zinc tended to increase the effect of stable zinc on the serum protein fractions. (auth)

21879 EFFECT OF IMMUNIZATION ON THE RATIO OF RABBIT SERUM PROTEIN FRACTIONS FOLLOWING CHRONIC ADMINISTRATION OF ^{65}Zn. Orlyanskaya, R. L. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 106-14(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 106-14(1965).

On immunization of rabbits given ^{65}Zn for a long time in a dose of 10.0 μCi/kg a tendency for the β-globulin fraction to increase was noted on the 16th and 67th day from the start of immunization. The γ-globulin fraction tended to fall on the 5th and rise on the 67th day as compared with the physiological controls. For all the groups of animals in series I the A/G coefficient during immunization was less than the initial values (before immunization). During the 67 days after the start of immunization no significant differences were found in the protein fractions in rabbits receiving ^{65}Zn in a dose of 10.0 μCi/kg and the group of animals receiving only stable zinc. On immunization of rabbits given ^{65}Zn for a long time in a dose of 0.1 μCi/kg the β-globulin fraction was observed to fall on the 17th, with a tendency to a fall on the 68th day. The γ-globulin fraction tended to fall on the 17th and 68th days as compared with the physiological control group. During reimmunization (68 to 74th days) of the rabbits receiving ^{65}Zn in a dose of 0.1 μCi/kg an increase was noted in the γ-globulin fractions not observed in the physiological control group. (auth)

21880 PHAGOCYTIC REACTION OF RABBIT NEUTROPHILS FOLLOWING CHRONIC EXPOSURE TO RADIOACTIVE ZINC. Volkova, A. P. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 115-18(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 115-18(1965).

Chronic administration to animals of ^{65}Zn in an amount of 0.1 μCi/kg for 10.5 months led to phasic changes in the phagocytic activity of the neutrophils and in hemopoiesis. The greatest changes were shown by the absorptive function of the neutrophils, these disturbances appearing 2 to 4 months earlier than the quantitative changes in the peripheral blood. (auth)

21881 CHANGE IN THE COMPLEMENT LEVEL IN RABBITS AFTER PROLONGED ADMINISTRATION OF RADIOZINC (^{65}Zn). Filatov, P. P. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 119-23(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 119-23(1965).

Burdening rabbits with radioactive zinc in a dose of 10 μCi/kg appreciably reduces the complement activity of the serum. Daily administration of 1 μCi of ^{65}Zn/kg of animal weight also reduces the complement level in the 13th month after the start of exposure. No fall in complement activity of the blood was noted on a daily administration of 0.1 μCi/kg. (auth)

21882 EFFECT OF THE SERUM OF RABBITS CHRONICALLY BURDENED WITH RADIOZINC (^{65}Zn) ON TISSUE CULTURES. Filatov, P. P. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 149-59(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 149-59(1965).

The tissue culture method makes it possible to detect in a distinct form the toxic properties of the sera of animals burdened for a long time with radiozinc. The results of the experiments suggest that depression of growth and death of tissue cultures stem from immunological factors—auto-antibodies. (auth)

21883 MORPHOLOGICAL CHANGES IN EXPERIMENTAL ANIMALS FOLLOWING CHRONIC EXPOSURE TO RADIOACTIVE ZINC (^{65}Zn). Gaidova, E. S. Toxicol. Radioactiv. Subst. (USSR) (Engl. Transl.); 5: 160-77(1970).

Translated from Mater. Toksikol. Radioaktiv. Veshchestv.; 5: 160-77(1965).

Chronic administration of radioactive zinc to rabbits produced pathological changes in the organs and tissues, primarily the blood forming ones. In the bone marrow there was an increase in the number of cells of the white series through the juvenile and rod nuclear neutrophils. In the spleen and lymph nodes hyperplasia of the reticulo-endothelial elements, appearance of foci of extramedullary hemopoiesis and increase in the numbers of rod nuclear neutrophils were found. The death of the test animals resulted in the main from complications: pneumonia suppurative necrotic processes spreading over the lymph nodes. In the liver and kidneys granular protein and fatty dystrophy were seen and deposition of amyloid was observed in the kidneys and spleen in some animals receiving 10 μCi/kg of radioactive zinc. In the gastro-intestinal tract there were atrophic and sclerotic changes of the mucosa and edema of the submucosa. Atrophic and dystrophic changes appeared at late times in the sex glands. The number of complications observed and the intensity of all the morphological lesions were directly related to the dose of radioactive zinc received and the time of its administration. (auth)

21884 ZONE-ELECTROPHORETIC, CHROMATOGRAPHIC, AND SPECTROGRAPHIC INVESTIGATIONS ON FIBRINOGENS OF NORMAL AND COBALT-TREATED RABBITS. Krantz, S.; Fiedler, H.; Lober, M. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Acta Biol. Med. Ger.; 25: 523-37(1970). (In German).

Fibrinogen of cobalt-treated rabbits was seen to differ from normal rabbit fibrinogen in its solubility, its electrophoretic mobility and uv absorption spectra. It proved markedly heterogenous in agarose gel electrophoresis. ^{58}Co(II) could be shown to bind with rabbit fibrinogen by radioelectrophoretic studies. Incubation experiments with EDTA did not produce any changes in biological and physiological properties of the cobalt fibrinogen. Gel-chromatographic studies on Sephadex G-200, Bio-gel P-300 and on Sepharose 4B showed no difference in the elution pattern between normal and cobalt fibrinogen. From DEAE cellulose both the fibrinogens are eluted in two fractions with cobalt fibrinogen leaving the column later than normal fibrinogen, because its isoelectrical point falls in a more acidic region. In the protein portions eluted at the beginning there could still be demonstrated normal coagulable protein. (auth)

21885 ROENTGEN X RAY EFFECTS ON THE OVARIES OF FOETAL MICE. Henricson, B.; Nilsson, A. (Kungliga Veterinarhogskolan, Stockholm). Acta Radiol., Ther., Phys., Biol.; 9: 443-8(Oct 1970).

Female mice were irradiated on the eleventh day of pregnancy with roentgen radiation of 20 R or 80 R. The female offspring were killed at the age of 28 or 56 days and oocytes and follicles were counted. There was a clear dose-related reduction of the oocytes, amounting to between 20 and 45%, in comparison with the controls. The fact that the reduction was less at the age of 56 days than at 28 days suggests a repairing process. (auth) (Sweden)

21886 DEPIGMENTATION OF HAIR IN TWO STRAINS OF MICE AFTER SINGLE AND FRACTIONATED DOSES OF ROENTGEN RAYS. Hulse, E. V.; Mizon, L. G. (Medical Research Council, Harwell, Eng.). Acta Radiol., Ther., Phys., Biol.; 9: 457-64(Oct 1970).

Depigmentation of hair after part-body x irradiation of mice was judged visually at weekly intervals. The onset, rate of increase and final degree of depigmentation at 25 to 40 weeks were dose-dependent. The threshold was above 250 rad. Dividing a dose into two equal fractions decreased the degree of depigmentation: a 24-hour interval was more effective than one of 6 hours. The observations allowed values for melanocyte survival to be deduced (D_{37} = 260 rad; n = 2.5). For fractionated doses D_2 to D_1 was 110 to 140 rad. (auth) (Sweden)

21887 INTENSIFICATION OF ANTIBLASTIC ACTION OF EMISSIONS OF THE OPTIC QUANTUM GENERATORS (LASERS). Kavetskii, R. E.; Sidorik, E. P.; Likhtenshtein, V. E.; Byalik, V. V. (Inst. of Experimental and Clinical Oncology, Kiev). Patol. Fiziol. Eksp. Ter.; 14: No. 3, 12-17(1970). (In Russian).

The possibilities of enhancement of the antiblastic effect of laser radiation were studied by combining the latter with administration of dyes, chemopreparations and iron ionophoresis upon the tumor. Inhibition of the growth of Gueren tumor of rats was the greatest when the action of neodymium laser and administration of trypan blue and Janus green was combined. A combination of laser radiation with ThioTEPA of fluorouracil proved to be effective in case of Garding-Passi melanoma. The results obtained pointed to a definitely specific action of optic quantum generators working in pulse regimen, this being conditioned by the briefness of radiation, its monochromatic character and coherence. (auth)

21888 POST-TETANY CHANGES OF ORTHODROMIC NERVE RESPONSE IN UNESTHESIZED RATS AFTER X IRRADIATION OF SPINAL CORD AND COMPENSATION. Semagin, V. N. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Dokl. Akad. Nauk SSSR; 191: 1427-9(21 Apr 1970). (In Russian).

Rats were given an x-ray dose of 1000 r to the lumbar region of the spine. Multiple tetanization was induced by the application of current pulses at frequencies of 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 per second. The dorsal nerves of the lumbar region of the spine were excited for a period of 10 seconds 5 times at each of the above frequencies. The appearance of post-tetany potentiation was observed in most of the rats 4 months after irradiation. A small number of rats did not show the establishment of post-tetany potentiation. It is proposed that irradiation at a

dose of 1000 r damages the presynoptic endings reversibly in some case, and irreversibly in other cases. In 4 months after the irradiation the reversibly damaged presynoptic endings are apparently restored. (TTT)

21889 INVESTIGATIONS ON THE TURNOVER OF ^{3}H-NORADRENALINE IN MICE HEARTS AFTER IRRADIATION WITH 600 AND 1200 R OF X-RAYS. Lipski, Slawomir; Hahn, Leszek. Acta Physiol. Pol.; 21: 663-9(Sep-Oct 1970). (In Polish).

The turnover of ^{3}H-noradrenaline and the total content of endogenous noradrenaline were investigated in x-irradiated mice hearts. Mice were given whole body irradiation at doses 600 R and 1200 R. No marked changes were found in the hearts of mice irradiated with a dose of 600 R. A decrease in the turnover rate of ^{3}H-noradrenaline was noted after a dose of 1200 R. The noradrenaline content dropped to 68%. (auth)

21890 STIMULATION OF HEMATOPOIESIS RESTORATION IN TOTALLY IRRADIATED AMINALS WITH THE AID OF SEEDING OF HEMATOPOIETIC CELLS IN THE EARLY POSTRADIATION PERIOD. Rudakov, I. A.; Rudakova, S. F.; Zyablitskii, V. M. (Inst. of Medical Radiology, Obninsk, USSR). Byull. Eksp. Biol. Med.; No. 10, 98-101(Oct 1970). (In Russian).

Wistar rats were subjected to gamma-irradiation in doses of 450 and 600 R respectively, and mice of CBA line were irradiated with doses of 600 and 850 R. During the first 1 to 2 hours after irradiation hematopoietic cells were seeded from the marrow of femoral bones. Studies carried out at different periods after irradiation showed that in treated (seeding) animals restoration of the number of myelokaryocytes and blood constituents occurred more rapidly than in nontreated animals. In mice sacrificed on the eleventh day after irradiation and seeded the number of endogenous colonies in the spleen was 2 to 5 times higher than in nontreated animals. The possible mechanisms of the favorable effect of postradiation seeding of hematopoietic cells on the hematopoiesis are discussed. (auth)

21891 INFLUENCE OF X-RAYS UPON THE MITOTIC ACTIVITY AND DNA SYNTHESIS IN THE ENDOMETRIAL GLAND EPITHELIUM IN MICE. Jonek, Jan; Klimkiewicz, Zdzislaw; Konecki, Janusz. Ginekol. Pol.; 41: 375-86(Apr 1970). (In Polish).

Autoradiographic technique was applied utilizing ^{3}H labelled thymidine for the evaluation of the mitotic activity and DNA synthesis in uterine glands' epithelium in mice after x ray irradiation in a dose of 600 r upon the whole body. It was demonstrated that the x ray irradiation influences a rapid decrease of the mitotic index which may be due to an inhibition of passage from the premitotic phase to the mitotic one. These changes are accompanied by an inhibition of intensiveness of DNA synthesis persisting till 36 hours after irradiation. (auth)

21892 MORPHO-FUNCTIONAL VARIATIONS OF ENDOCRINE ORGANS IN EXPERIMENTAL RADIATION CHIMERAS. Zaitseva, K. K.; Butomo, N. V.; Fomina, G. S. (Kirov Academy of Military Medicine, Leningrad). Dokl. Akad. Nauk SSSR; 193: 703-5(21 Jul 1970). (In Russian).

Current results indicate that the secondary sickness involving radiation chimeras causes strong disturbances in the metabolism. This problem was examined by studying the morpho-functional state of the adrenal and thyroid glands, the frontal portion of the pituitary gland of long-lived allogenic radiation chimeras. The changes observed were compared with the degree of development of the transplantate's reaction against the host. Male CC57W-line mice, exposed to 750 R of γ radiation were used as recipients; 24 hours after the irradiation, allogenic bone-marrow cells from SZN-line mice were injected intravenously into the animals. The test and central animals were decapitated 40 to 50 days after irradiation. Similar tests were also carried out with male rabbits, exposed to a total of 1100 R of γ radiation in 2 stages. The endocrine organs were examined during the clinical of the radiation sickness. The results indicated that the long-lived allogenic chimeras exhibit hyperfunction of the cortex of adrenal glands, hypofunction of the thyroid and some activation of thyrotropic function of the frontal portion of the pituitary. In allogenic chimeras without signs of homodogous sickness, and in syngenetic chimeras, the hypercorticism and the hypofunction of the pituitary gland were manifested only weakly or not at all. Therefore, some of the observed effects must be attributed to transferred radiation injury. (TTT)

21893 HISTOPATHOLOGY OF RADIATION-INDUCED RETINITIS. Kanbai, G. G. Vestn. Oftal'mol.; No. 3, 63-6(May-June 1970). (In Russian).

The effects of penetrating radiation on the retina at various periods of radiation sickness were studied. Adult rabbits were subjected to whole-body x irradiation (800 R). The resulting radioinduced retinitis showed that by virtue of their onto- and histogenetic development there was a latent period of the lesion in each of the retinal layers. Interstitial substance of the retina was the first to suffer. Further involvement of individual retinal layers bore a retrograde nature. Retinal layers that developed at a later date as a result of their histogenesis suffered earlier. The oldest and first developed structures offered more resistance. In the ganglionic retinal layer first to suffer were fine medium-sized nuclei, whereas the big ones offered greater resistance. It was demonstrated that the involvement of the retinal layers proceeded in an order that was the inverse of their ontogenic development, while restoration repeated the process of their development during ontogenesis. In the treatment, attempts were made to use dithiol containing a sulfogroup (SO_3). (auth)

21894 EFFECTIVENESS OF SHIELDING OF DIFFERENT BODY PORTIONS DURING REPEATED IRRADIATIONS WITH PROTONS. Nevskaya, G. F.; Abramova, G. M.; Ginsburg, E. V.; Kalandarova, M. P. Kosm. Biol. Med.; 4: No. 5, 20-3(Sep-Oct 1970). (In Russian).

Dogs were exposed to 700 rads of proton irradiation (two exposures of 350 rads each with an interval of 45 days). The pelvic zone and the upper portion of the abdomen making 15% of total body weight were exposed. The protective effect was found to be related to the size of the undamaged portion of bone marrow. This amounted to 15% and 5% of total bone marrow in the dog skeleton when the pelvis and the abdomen, respectively, were shielded. During a single or repeated irradiation with minimal absolutely lethal doses, the shielding of 5% bone marrow failed to repair hemopoiesis to a sufficient degree and the changes in the tested parameters were more significant than in animals with 15% bone marrow shielded. These changes became manifest not so much in hemopoiesis inhibition as in the rate and degree of bone marrow reparation and level of recovery of blood indexes. (auth)

21895 ELECTROCARDIOGRAPHIC CHANGES FOLLOWING X-IRRADIATION OF THE CANINE HEART. Badran, Ahmed M.; El-Naggar, Anas M.; Abdallah, Ahmed; Mahmoud, Kamal A. (Atomic Energy Establishment, Cairo). Amer. Heart J.; 79: 648-52(May 1970).

The effect of deep x irradiation on the canine heart at doses of 1,000 to 8,000 roentgens was studied with reference to the electrocardiogram, serum transaminase levels, and cardiac size. T-wave changes were the most conspicuous, starting at doses of 2,000 roentgens. Doses of 5,000 roentgens and above were found to be lethal. No significant change occurred in the transaminase level or cardiac measurements. The significance of these findings is discussed. (auth)

21896 TIME DEPENDENT COURSE OF ACUTE BRAIN EDEMA AFTER RADIATION. Cervos-Navarro, J. (Freie Univ., Berlin). Acta Neurochir.; 22: 43-51(Apr 1970). (In German).

The cerebral medulla of monkeys was irradiated with x rays. The development and decrease of the subsequent brain edema was observed with regard to the correlation of electron microscopic and morphometric results. 6 hours after x ray treatment the extracellular spaces begin to increase, reaching their maximum after 48 hrs, and decrease again after 6 dys. The structures of the medulla that may be responsible for the restitution are discussed. The endothelium of the capillaries and their functional activity are the main factor in this process. (auth)

21897 HISTOCHEMICAL AND HISTOLOGICAL CHANGES IN THE HEART AT EARLY PERIODS AFTER ITS LOCAL IRRADIATION. Lushnikov, E. F. (Obninsk Inst. of Medical Radiology, USSR). Kardiologiya; 10: 101-5(Feb 1970). (In Russian).

In experiments staged on rabbits histochemical and histological alterations in the heart were determined following local irradiation in doses of 600 and 1200 rad. During the first hours after irradiation against the background of circulatory disorders of the myocardium there is noted a disappearance of glycogen from muscle cells, as well as a disturbance of the permeability of mitochondrial membranes, this being manifested by the formation of large, intensively stained and diffuse edges of diformasan granules. Subsequently metabolic changes tend to progress, there appear dystrophy and necrosis of muscle cells and at the site of the latter connective tissue proliferates. (auth)

21898 PRE-IMPLANTATION DEATH OF MOUSE EGGS CAUSED BY IRRADIATED FOOD. Moutschen-Dahmen, M. (Univ., Liege); Moutschen, J.; Ehrenberg, L. Int. J. Radiat. Biol.; 18: 201-16(1970).

Feeding of mice (C57BL males and/or C57BR females) for two mos. before mating with 50% of the standard complete diet (solid cakes) irradiated with 5 Mrads γ radiation provoked a significant increase of pre-implantation embryonal deaths. In contrast to a preliminary experiment, no increase of post-implantation deaths (deciduomata) was noted. Treatment of both sexes or of males appeared to be very efficient. The pre-implantation deaths should be interpreted as a dominant lethal mutation associated with gross chromosomal aberrations, such as centromeric breaks repeatedly found to be induced by irradiated materials. Other interpretations, such as enhanced ageing, cannot be ruled out on the basis of the present data. (auth) (UK)

21899 COMPARATIVE STUDY OF THE EFFECTS OF ULTRAVIOLET RADIATION ON THE EYE. Pitts, Donald G. (Univ. of Houston, Tex.). Amer. J. Optom.; 47: 535-46(Jul 1970).

An argon gas forced transpiration arc (FTA) was used to produce a high intensity 180 nm to 2.5 u continuous spectrum. Rabbit and primate eyes were exposed to uv from 210 nm to 320 nm, in 10 nm wavebands, to establish photo-ophthalmia thresholds. Human eyes were exposed at 280 nm to establish a threshold and correlate with the animal research. The uv action spectrum ranged from 210 to 320 nm. Both animal thresholds peaked at 270 nm with the rabbit value at 0.054×10^6 ergs/cm^2 and the primate at 0.03×10^6 ergs/cm^2. (auth)

21900 STUDY OF THE SURVIVAL OF FROG EMBRYOS SUBJECTED TO X-IRRADIATION AT THE STAGE OF ZYGOTE. Partskhaladze, N. N. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 60: 685-7(Dec 1970). (In Russian).

Experiments were carried out on fecundated spawns of frog. The dose of irradiation was 10, 25, and 50 R. The survival of embryos during 25 days after fecundation served as a criterion of the action of irradiation. The mortality of frog embryos subjected to irradiation in low doses at the maximal radiosensitivity stage of an ovule was found to be markedly higher than that at the maximal radioresistance stage, this difference decreasing with increasing doses. (auth)

21901 EFFECT OF LOCAL GRAFT IRRADIATION ON REJECTION OF CANINE CARDIAC ALLOGRAFTS. Graham, Walter H.; Childs, James W.; De Giorgi, Lucio S.; (and others) (Medical Coll. of Virginia, Richmond). J. Thorac. Cardiovasc. Surg.; 60: 730-6(Nov 1970).

Dogs were given cardiac transplants and acute rejection was detected by means of the electrocardiogram. Gamma radiation was then delivered to a localized area of the thorax in doses up to 1500 R. Open cardiac biopsy of the left ventricle was repeated following radiation treatment. Gross pathological changes, edema, and contractility of the graft were observed and electron microscope observations were made on tissue sections. It was found that doses greater than 600 R had a favorable effect on the graft. Results suggested that local irradiation can be effective in reversing acute rejection of the transplanted heart. (H.L.W.)

21902 ESTERASES IN RAT LIVER AND BLOOD AFTER X IRRADIATION AND THIOPHOSPHAMIDE TREATMENT. Savitskii, I. V.; Levitskii, A. P.; Lozitskii, V. P. (Medical Inst., Odessa). Vop. Med. Khim.; 16: 460-3(Sep-Oct 1970). (In Russian).

The activity of lipase, carboxylesterase, and arylesterase in rat liver and blood serum after x irradiation (at a dose 600 R) or thiophosphoamide treatment was studied potentiometrically. The decrease in liver esterases activity 1 hr after the irradiation, and increase 1 hr after thiophosphoamide treatment was found. At the successive time intervals (1, 3, 7, and 10 days) the action of radiation and thiophosphoamide was similar and leads to the decrease in esterase activity. The effect of radiation and thiophosphoamide on blood serum esterases was also similar and resulted in the elevation in the activity of carboxylesterase at all time intervals. At the same time the activities of lipase and arylesterase were changed only slightly. The repeated treatment of animals with the drug at a small doses does not induce the activation of serum carboxylesterase, but the tendency to the increase in liver lipase and serum arylesterase level was noted. (auth)

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Refer also to abstracts 21539, 21601, 21608, 21679, 21685, 21699, 21701, 21703, 21712, 21713, 21734, 21738, 21743, 21748, 21781, 21795.

21903 (AD-711360) COMPARATIVE STUDY OF THE EFFECTS OF ULTRAVIOLET RADIATION ON THE EYE. Final Report, October 1, 1968-September 30, 1969. Pitts, Donald G.; Bruce, William R.; Tredici, Thomas J. (School of Aerospace Medicine, Brooks AFB, Tex.). Jul 1970. 83p. (SAM-TR-70-28). NTIS.

A fluid transpiration arc (FTA) filled with argon gas was used to produce a high intensity continuous spectrum. Animal and human exposures were made to establish the photokeratitis threshold and abiotic action spectrum. The abiotic action spectrum ranged from 210 to 320 nm. The peak of the uv threshold curve was at 270 nm for the rabbit and the primate. The rabbit photokeratitis threshold was 0.05×10 to the 6th power ergs/cm^2 at 270 nm. The primate threshold was 0.04×10 to the 4th power ergs/cm^2 at 270 nm. The human threshold at 280 nm was 0.05×10 to the 6th power ergs/cm^2. Formulas and calculations are given for protection against uv encountered in the space environment. (auth) (USGRDR)

21904 (AD-712845) INDUCED FIELDS AND HEATING WITHIN A CRANIAL STRUCTURE IRRADIATED BY AN ELECTROMAGNETIC PLANE WAVE. Shapiro, A. R.; Lutomirski, R. F.; Yura, H. T. (RAND Corp., Santa Monica, Calif.). Sep 1970. 33p. (P-4458). NTIS.

The induced fields and the static heating patterns within a multi-layered spherical model that approximates the primate cranial structure irradiated by plane waves in the microwave spectrum are calculated. The relation of the model to the biological structure and the sensitivity of the results to the uncertainties in the dimensions and electrical properties of biological material are investigated. A method of solution for both the scattered and interior fields for a sphere with an arbitrary number of electrically different concentric layers is developed in a form readily amenable to machine computation. It is shown that the semi-infinite slab model is inappropriate for calculating the microwave radiation dosage to the human head and similar structures. (auth) (USGRDR)

21905 (ANL-7760(Pt.2)) RADIOLOGICAL PHYSICS DIVISION, CENTER FOR HUMAN RADIOBIOLOGY ANNUAL REPORT, JULY 1969-JUNE 1970. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 258p. Dep. NTIS.

Research on human radiobiology is presented in 19 sections. Separate abstracts were prepared for 13 of these sections. Other material covered includes: alkaline earth metabolism in bone, chondroclastic resorption in long bones of newts, development and healing of rickets in rats, mineral metabolism in skeletons of teleosts, and electron microscope measurements of alkaline earth transport. (M.C.G.)

For abstracts of individual sections see: 20907, 20945, 21228, 21382-21384, 21545, 21685, 21750, 21813, 21830, 21906, and 21907.

21906 (ANL-7760(Pt.2), pp 1-17) SOME DOSE-RESPONSE RELATIONSHIPS FOR TUMOR INCIDENCE IN RADIUM PATIENTS. Rowland, R. E.; Failla, Patricia M.; Keane, A. T.; Stehney, A. F. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969-June 1970.

A population of 777 radium cases for whom the total dose received has been calculated was obtained by combining the MIT and the ANL-ACRH studies. Within this population a total of 71 malignancies were considered to be radiation induced: 51 sarcomas and 20 carcinomas. Dose-response functions of the form Incidence = KDe^{-D/D_0} and $I = KD^2e^{-D/D_0}$ were examined and found to provide reasonable fits to the data over most of the dose range. The unit of dose employed was the total number of rads accumulated by the skeleton from acquisition of radioactive material to death, or to diagnosis of a malignancy, or if neither of these events had occurred, to January 1, 1969. The calculation includes the contribution of ^{228}Ra and daughters as well as ^{226}Ra and daughters. (C.H.)

21907 (ANL-7760(Pt.2), pp 133-53) ESTIMATES OF THE RADIATION-INDUCED LEUKEMIC RISK IN MAN. Marinelli, L. D. (Argonne National Lab., Ill.).

In Radiological Physics Division, Center for Human Radiobiology annual report, July 1969-June 1970.

The radiation-induced leukemic risk in man was calculated from data available in the literature up to mid-year 1970 on leukemogenesis induced by internal and external radiation. The calculations support the validity of the use of integral dose in estimates of risk in partial exposure, and the lack of effect of dose fractionation. Both results apply to high dose rates. There is some evidence of lowered leukemogenic efficiency at low dose rates, in accord with experimental evidence in laboratory

animals. The results, however, are not beyond the limits of statistical uncertainty. (auth)

21908 (EUR-4535) RADIATION HEMATOLOGY ANNUAL REPORT 1969. Stich, W. (Gesellschaft fuer Strahlenforschung m.b.H., Freiburg (West Germany). Institut fuer Haematologie). 5 Aug 1970. 20p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 3,-.

Scientific research in 1969 was focused on three main problems of leukemia, hemosubstitution and bone-marrow transplantation, hematopoiesis, and replacement of blood cells. These are closely linked to the still unsolved, basic problems of radiation hematology, particularly the diagnosis, pathogenesis, and therapy of hematologic radiation injuries. The individual problems were dealt with by morphologic, biochemical, biophysical, immunologic, genetic, and clinico-pharmacologic methods as a continuation and extension of previous work. Some of the results are discussed. In cases of chronic myeloid leukemia the mitotic indices were reduced by kinetic proliferation, maturation was delayed, and the cytokinesis and maturation times were extended, so that the abundance of granulopoietic cells in the bone-marrow is due to their longer residence time, i.e. accumulation, rather than increased proliferation. In cases of lethal dose, whole-body irradiation, therapy consisted of allogenetic bone-marrow transplantation with pretreatment of the donor with heterologous antilymphocyte serum. This enabled the receiver's secondary ailment to be brought under control. In quantitative autoradiography a new method was evolved for the determination of DNS synthesis in bone marrow cells. The resynthesis of DNS can be completely inhibited by the addition of amethopterin, so that the DNS precursor requirements of the bone marrow cells are provided by exogenous ^{14}C thymidine only. The new method also enables certain amounts of 10^{-19} mol DNS to be identified. For further specific results reference should be made to the appended list of scientific publications during the period. (tr-auth)

21909 CUTANEOUS MASTOCYTOSIS: AN UNUSUAL RADIATION DERMATITIS. MacDonald, A. (St. Mary's Hospital, London). Proc. Roy. Soc. Med.; 64: 29-30(Jan 1971).

The history of a secondary reaction to post-operative x radiation is summarized. Six weeks after surgery for breast carcinoma, a woman of 61 received 2,400 R to the chest wall and lymph nodes over a period of three weeks. Four months later after the primary reaction had ceased, there was a skin eruption over the exact area exposed to radiotherapy, with a few additional papules on arms and thighs. Biopsies confirmed the mastocytosis diagnosis. (UK)

21910 CHROMOSOME ABERRATIONS CAUSED BY IONIZING RAYS. Neuhaeuser, G. Hippokrates (Stuttgart); 41: 295-7(Jun 1970). (In German).

Data are reviewed on chromosome changes in man induced by ionizing radiation. Experience from Hiroshima and Nagasaki is cited as well as irradiation of women during their first trimester of pregnancy. (H.B.G.)

21911 BONE LESIONS FOLLOWING EXTENSIVE IRRADIATION OF GYNAECOLOGICAL CANCERS. (A REPORT ON 20 CASES SEEN AT THE RENE HUGUENIN CENTER). Delouche, G.; Brunet, M.; Guerin, P.; Gest, J. (Centre Rene Huguenin, Saint-Cloud, France). Ann. Radiol.; 13: R793-807(1970). (In French).

Twenty cases of bone lesions of the hip were observed out of the 841 patients (2.37% of the cases) treated with high doses of γ radiation (6000 rads ^{60}Co teletherapy) delivered to the pelvis. Lesions were most commonly observed in the acetabulum. These lesions can be avoided by taking the appropriate precautions during irradiation. Almost all of the patients in the present series (19 out of 20) had been treated with rotation therapy; the lesions have practically disappeared with the introduction of fixed fields. The risk appears to have been greatest in patients undergoing surgery to the pelvic region, whereas intercavitary treatment did not introduce significant risks. As a result of these observations, doses to the pelvic cavity have been reduced and surgery abandoned in those case which can be treated by radiotherapy, for example stage II cancer of the cervix. (auth) (France)

21912 INDICATIONS FOR THERAPEUTIC PROCEDURES IN CARCINOMA PATIENTS AFFECTED WITH OSTEORADIONECROSIS AFTER IRRADIATION OF THE FACIAL AND NECK REGION. Anastasov, K.; Bezensek, A. Stomatologiya (Sofia); 50: 449-53(1968). (In Bulgarian).

On the basis of clinical observations of 16 patients, treated in the Department of Facial Surgery at SISHI, the therapeutic procedures in cases of radionecrosis in the jaw region are described. The difficulty in diagnosing a pure radionecrosis of the jaw and the facial bones is pointed out. Refraining from extraction in the case of purulent processes of dental origin, a view held by many authors, is considered ungrounded since the extraction wounds heal normally, though more slowly, when effectively treated with antibiotics. Radical surgical intervention is recommended in radionecrosis of the mandible. (Abstr. Bulg. Sci. Med. Lit.)

21913 PRENATAL RADIATION EXPOSURE AND CHILDHOOD CANCER. Stewart, A.; Kneale, G. W.; Burch, P. R. J. (Oxford Univ.). Lancet; 1: 42-3(2 Jan 1971).

The findings of the Oxford survey of childhood cancers were analysed with reference to the reasons for prenatal x ray exposures and the number of films taken. Data on 7952 case/control pairs showed that for both types of radiographic investigation, (less than two films and more than two), the dose-response effect was similar to the one describing all children with prenatal exposures. Arguments are presented for the one-hit theory, (a tiny dose may convert a mitotically competent cell into a cancer precursor) and the constitutional hypothesis. The reasons for the difference in film numbers may or may not be connected with the risk of bearing a child predisposed to childhood malignancy. (UK)

21914 PROPHYLACTIC ULTRAVIOLET IRRADIATION OF PRESCHOOL CHILDREN IN MOSCOW. Andrianova, A. I. Gig. Sanit.; No. 10, 30-3(Oct 1970). (In Russian).

The preschool-age children of Moscow were exposed during the winter to additional uv irradiation from artificial sources used in the system of general lighting and under conditions of a photarium. The finding was that the Moscow children require preventive irradiation from the end of October to March. The daily ultraviolet dose should be not less than 3000 mcvt. min./cm^2. (auth)

21915 CATARACT DUE TO ACUTE WHOLE BODY IRRADIATION IN YUGOSLAVIA IN 1958. Jammet, H. (CEA, Fontenay-aux-Roses, France); Haye, C.; Mathe, G.; Pendic, B. Arch. Ophthalmol.; 30: 567-70(1970). (In French).

A case of bilateral opacification of the crystalline lens subsequent to accidental acute irradiation is reported. Opacity of the crystalline lens occurred 7 years after the accident. Prognosis appears favorable. (auth) (France)

21916 INVESTIGATION OF CHROMOSOMAL ABERRATIONS IN LEUKOCYTES OF THE PERIPHERAL BLOOD. Tsaranova, L. I.; Bochkov, N. P. (Inst. of Medical Radiology, Obninsk, USSR). Med. Radiol.; 6: No. 1, 29-35(Jan 1971). (In Russian).

Data are presented on the incidence of chromosomal aberrations in peripheral blood leukocytes following γ irradiation using one course of treatment in two groups of oncological patients. The results derived were compared with data of in vitro irradiation. The level of chromosomal aberrations was similar in all groups and in all doses, and ranges within 1%. Consequently, irradiation does not induce in vivo chromosomal aberrations. Dicentric and circular chromosomes are always accompanied by one pair of fragments, i.e., a complete asymmetric exchange takes place. Since the lymphocyte population in the referred to doses in partial irradiation of the body is too heterogenic, it is inexpedient to calculate equations and coefficients of aberrations. The number of cells with aberrations in both groups of patients has a dependence which significantly differs from linear. In patients with esophageal tumor all indices of the number of aberrations may be described by equations of linear dependence, this meaning the sum of results of the effect of each fraction. In patients with tumor of the urinary bladder the linear dependence follows only the number of fragments this, apparently, explaining the artificial reduction in the number of affected cells. An analysis of the quantity and types of chromosomal aberrations that injuries of chromosomes do not stabilize directly after irradiation. (auth)

21917 ALTERATION O .E CONTENT OF N LEIC ACIDS IN THE BLOOD OF PATIENTS WITH CANCER OF THE ESOPHAGUS AND STOMACH IN RADIATION TREATMENT OF 25 MeV BETATRON. Fridlyand, I. B.; Ginzburg, M. B.; Kornev, I. I.; Zverev, M. P.; Preobrazhenskii, Yu. V. (Inst. of X-Ray and Radiology, Moscow). Med. Radiol.; 6: No. 1, 22-8(Jan 1971). (In Russian).

The content of nucleic acids and leukocyte count were studied in patients with cancer of the esophagus and stomach before and during radiation treatment of 25 MeV x radiation. A definite correlation was noted between the clinical effect of treatment and the content of nucleic acids in the blood: in cases of direct favorable effect of treatment a reduction of the content of nucleic acids and then a gradual rise was noted. In progress of the neoplastic process the level of nucleic acids in the blood steadily declined. The leukocyte count showed that there exists no correlation be-

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tween the number of leukocytes and the content of nucleic acids in the blood. (auth)

21918 OCHERKI KOSMICHESKOI RADIOBIOLOGII. (Outlines of Cosmic Radiobiology). Saksonov, P. P.; Antipov, V. V.; Davydov, B. I. Problemy Kosmicheskoi Biologii. Tom IX. (Problems of Space Biology. Volume 9). Moscow; Izdatel'stvo Nauka (1968). 532p.

The biological effects of cosmic radiation, basic to a wide range of biological objectives, are considered. Generally, these effects are discussed on the basis of the combined effects of irradiation and other space flight factors determined in mockup experiments and in actual space flights. These effects, determined under experimental and clinical conditions simulating the problems of space radiobiology, are analyzed. New approaches to the basis for determining MPD for space craft crews and equipment in orbital and interplanetary flights are discussed. Systems primarily for insuring radiation protection on short-term and prolonged space flights are also considered along with the possibility of using a drug to increase the resistance of the organism to the effects of cosmic radiation in conjunction with another against extreme flight factors. The book is intended for radiobiologists, physiologists, and other specialists interested in the problems of safe space flight. It is also of interest to a wide range of scholars attracted to the problems of space radiobiology. (tr-auth)

21919 EFFECTS OF IONIZING RADIATION ON THE HUMAN KIDNEY. Bollini, V. (Univ., Bologna); Bono, F.; Bonomini, V.; (and others). Radiobiol. Radioter. Fis. Med.; 24: 225-44(Jul-Aug 1969). (In Italian).

A study was made of a large human and experimental case list to specify renal early and late irradiation damages. Early renal reactions (not over 3 months) are clinic-functionally not evident. Histopathological examinations, executed on man also with electronic microscopy, show in these cases, a glomerular damage whose correct terms are hard to define (glomerulose, glomerulitis, etc.). Late renal reactions (4 months—16 years) don't appear with clinic signs of renal damage. Little deviations from normal of blood renal flow and glomerular filtration can be shown. In the cases, histo and ultra-structural studies show typical interstitial sclerotic lesions whose degree seems related to the dose. (auth)

21920 OPUKHOLI CHELOVEKA I ZHIVOTNYKH, VYZVANNYE VNESHNIM OBLUCHENIEM. (Tumors Induced in Man and Animals by External Radiation). Svyatukhin, M. V.; Sorokina, Yu. D.; Turusov, V. S. Moscow; Izdatel'stvo Meditsina (1969). 232p.

This book deals with literature on human tumors and leucoses induced by external x irradiation. Tumors developing after medical irradiation are taken into special consideration along with tumors induced by total and local irradiation, influence of chemical radioprotectors on tumor incidence, and combined action of radiation and chemical carcinogens. (P.B.M.)

21921 EARLY EFFECTS OF LOCALIZED SINGLE DOSES OF IONIZING RADIATION ON HUMAN BONE MARROW. Stefani, S.; Monti, A. (Veterans Administration Hospital, Hines, Ill.). Acta Radiol., Ther., Phys., Biol.; 9: 449-56(Oct 1970).

The effect of localized single doses of ionizing irradiation on normal bone marrow of patients with bronchogenic carcinoma was studied. The studies were made as a function of dose and of time. Quantitative modifications consisted of a marked percentage decrease in the erythroblasts and a less marked percentage decrease in the precursors of the granulocytic series accompanied by a shift to the right. A noticeable relative increase in lymphocytes and plasma cells starting one day post-irradiation was observed. (auth) (Sweden)

21922 GENETIC RAY HAZARDS. Zsebok, Zoltan. Magy. Radiol.; 22: 257-64(Oct 1970). (In Hungarian).

The basal problems of the genetic radiation hazards are reviewed. The results of the experimental examinations and the symptoms observed in the individuals who had suffered radiation injury after the attack in Japan are discussed. All these point unanimously to the fact that various mutagen influences are of the same importance for the latter generations as the radiation injury of the genetic matter. (auth)

21923 LEUKEMIA IN ATOMIC BOMB SURVIVORS, HIROSHIMA AND NAGASAKI, OCTOBER 1, 1950 TO SEPTEMBER 30, 1966. Ishimaru, Toranosuke; Hoshino, Takashi; Ichimaru, Michito; (and others) (Atomic Bomb Casualty Commission, Hiroshima. Atomic Bomb Casualty Commission, Nagasaki). Radiat. Res.; 45: 216-33(1971).

The incidence of leukemia in fixed cohorts of atomic bomb (A-bomb) survivors in Hiroshima and Nagasaki cities has been analyzed for the period 1 October 1950 to 30 September 1966. Leukemogenesis has been examined in relation to radiation dose, using the tentative 1965 dose estimates for the survivors. It was shown again that the risk of leukemia was substantially elevated among those survivors who received significant doses of radiation. In Hiroshima, indeed, the risk of leukemia was elevated even in those exposed to less than 50 rads, with no evidence of a threshold. If other possible sources of variation are ignored, it appears that the relative biological effectiveness of neutrons as compared with gamma rays for leukemogenesis is around five. The leukemogenic effect of radiation depends on the sex and age of the subject at the time of the bombings and varies for different types of leukemia. Although the annual incidence has been declining since the peak years of 1951–52, the evidence indicates that the risk of leukemia had not yet returned to control levels even 15 to 21 years after exposure to the A-bomb. (auth)

21924 MULTIPLE PRIMARY MALIGNOMA INCLUDING X-RAY CARCINOMA IN FAMILIAL CANCER SUSCEPTIBILITY. Gartmann, H.; Zingsheim, Margret (Univ., Cologne). Z. Haut-Geschlechtskr.; 45: 117-24(1 Sep 1970). (In German).

The case history is given of a 36 year old woman who developed at 18 years of age, a parotic tumor with cancerous transformations, and at 35 years a mammary carcinoma. In the same year, a radiation ulcer occurred that subsequently was diagnosed as a squamous cell carcinoma with basilar transformations along the edges; radiation was administered at the age of 12 years to the neck because of glandular tuberculosis. In addition, a familial cancer susceptibility existed. Histopathologic peculiarities of radiation-induced cancer are discussed and presented in histological pictures. (H.B.G.)

Radiation Effects on Plants

Refer also to abstracts 21583, 21584, 21617, 21619, 21622, 21650, 21651, 21653–21655, 21657, 21664, 21666, 21667, 21670–21674, 21736, 21972, 21985, 21989, and 21991.

21925 (TID-24270, pp B,291-8) SOME AUTECOLOGICAL STUDIES OF ORMOSIA KRUGII. Edmisten, Joe (University of West Florida, Pensacola, Dept. of Biology).

From Tropical rain forest.

Five experiments were done with seedlings of Ormosia krugii. Germination was best when seed coats were digested by Rhizobium. Ormosia seedlings with normal drip tips lost less calcium, magnesium, and zinc in leaching experiments than plants without drip tips. Seedlings in hydroponic solutions developed the classic symptoms of calcium, magnesium, and nitrate deficiencies when these ions were missing from the solution. A population of seedlings exposed to a light intensity of 2500 ft-c fixed carbon at a rate of 0.09 $g/m^2/hr$, whereas plants exposed to 30 ft-c had a rate of 0.05 $g/m^2/hr$. In one experiment seedlings were subjected to acute doses of γ radiation on roots, shoots, and both roots and shoots. Radiation levels of 5000 and 2500 R were administered over 70 and 140 min periods. Stem growth, leaf fall, and innate voltage of the seedlings were monitored for one month after treatment for indications of radiation damage. (auth)

21926 (TID-24270, pp C,3-22) AEC RAIN FOREST PROGRAM. Odum, Howard T. (North Carolina Univ., Chapel Hill.).

From Tropical rain forest.

The experimental design of the forest irradiation experiment at El Verde, related studies, and the sequence of events in the AEC Rain Forest Program were described. After 2 yr of intensive preirradiation studies, the forest was irradiated by a 10,000 curie cesium source for 92 days early in 1965. Effects of the irradiation and the course of recovery were studied in the 6 yr that followed. The Radiation Center was compared with a similar area to the south which, having been disturbed only by the trampling of the scientists, served as the control. A third center to the north was cut by machete to resemble the Radiation Center in its open aspect the first year following irradiation. Also included were studies of mineral cycles, fallout, tracers, aspects of forest metabolism, and comparative surveys made in Panama, Dominica, and elsewhere to place the Puerto Rican results in perspective among tropical forests. (auth)

21927 (TID-24270, pp C,49-52) KINETIC MODEL OF RADIATION RESPONSE TO FIELD IRRADIATION. Dienes, G. J. (Brookhaven National Lab., Upton, N. Y.).

From Tropical rain forest.

A kinetic model of radiation response which includes varying rates of reversible recovery was used to compute the areal distribution of radiation damage around a field radiation source. In the model biological components with faster repair rates were found to survive several times greater dosages. On a log to log plot, the curves predicted for survival vs. distance from the source have a similar and characteristic shape, being displaced toward the radiation source when recovery processes are rapid. (auth)

21928 (TID-24270, pp D,3-75) EFFECTS OF GAMMA RADIATION ON THE FOREST AT EL VERDE. Odum, H. T.; Murphy, P.; McCormick, F.; Schinhan, C. (North Carolina Univ., Chapel Hill); Drewry, G.; Morales, E. (Puerto Rico Nuclear Center, Rio Piedras); McIntyre, John A. (Syracuse Univ., N. Y.).

From Tropical rain forest.

With documentation by photographs, with counts of leaves, shoots, and seedlings, and with instrumental records of optical density as an index of vegetation mass, a summarizing chronological account was given of defoliation, regeneration, and succession following the 1965 irradiation. In the first post-irradiation year there was bare ground and a rapid fall of green and yellow leaves from the canopy out to 25 m from the source, the area of defoliation continuing to spread until 1967. The most prominent growths were from regeneration, new seedling growths, and the rapid spread of the shrub Palicourea riparia, whose continuous flowering and bright green foliage characterized the postirradiation period. In 1967, as regenerative growth covered the center of the area, palms were still dying in the periphery where accumulated radiation had been 5000 R. (P.B.M.)

21929 (TID-24270, pp D,77-102) EFFECTS OF ^{137}Cs RADIATION ON VEGETATION STRUCTURE AND OPTICAL DENSITY AT EL VERDE. Desmarais, A. Paul; Helmuth, Billy T. (Army Engineer Waterways Experiment Station, Vicksburg, Miss).

From Tropical rain forest.

The vegetation physiognomies of both the Radiation (WES Site V-93) and South Control (WES Site V-92) Centers in the El Verde rain forest were described in 1964. A second description of the Radiation Center was made approximately 16 mon later. This was 7 mon after it was exposed intermittently to 10,000 curies of radiation from a ^{137}Cs source for about 3 mon. Optical density data were collected at both centers between May 1965 and July 1966. Significant changes were detected in both vegetation physiognomy and optical density out to a distance of about 12 m from the center of the radiation site. Infrared frequencies penetrate deeper into the vegetation than do visible frequencies. (P.B.M.)

21930 (TID-24270, pp D,141-71) TREE GROWTH AT EL VERDE AND THE EFFECTS OF IONIZING RADIATION. Murphy, Peter G. (State Univ. of New York, Syracuse. Coll. of Forestry).

From Tropical rain forest.

Gamma radiation effects on the radial growths of 250 tree trunks of five principal species were measured monthly with vernier bands at El Verde from December 1963 to May 1966. The growth rate of Dacryodes excelsa receiving more than 7000 R was less than half the normal rate, and all trees in the 8500 to 15,000 R range showed at least temporary growth retardation. All trees that received between 15,000 and 40,000 R developed sparse or discolored foliage or both, and those receiving more than 40,000 R died except for some root sprouts shielded by rocks. (P.B.M.)

21931 (TID-24270, pp D,173-5) GERMINATION OF SEEDS OF CERTAIN TROPICAL SPECIES. Quarterman, Elsie (Vanderbilt Univ., Nashville, Tenn. Dept. of Biology).

From Tropical rain forest.

Seeds of three species, Dacryodes excelsa, Linociera domingensis, and Smilax coriacea, whose fruits were subjected to 5 to 50 kr, were planted to test the effects of radiation on germination. Four groups of plots consisting of combinations of shaded, unshaded, bare, and litter-covered soil were set up. Germination of irradiated Dacryodes seeds was severely reduced; that of Smilax was not. Seeds of Linociera proved to be immature. Germination of Dacryodes seeds was better in the shade than in the sun regardless of soil surface. Germination of Smilax seeds was better on bare than on litter-covered soil, without regard to shade. (auth)

21932 (TID-24270, pp D,183-8) STUDIES OF PHYTOLACCA ICOSANDRA. Edmisten, Joe (University of West Florida, Pensacola. Dept. of Biology).

From Tropical rain forest.

Experiments were performed in an attempt to elucidate the mechanisms responsible for the transport and germination of Phytolacca icosandra seeds. Seeds passed through the guts of young chickens with and without subsequent γ radiation failed to germinate in six tests, but 74.6% germination was obtained with seeds fed to white-throated sparrows. Some increase of germination was obtained with weak acid and higher soil temperatures of 90°F. (P.B.M.)

21933 (TID-24270, pp D-189-92) POSTIRRADIATION WOODY SEEDLINGS. Duke, James A. (Department of Agriculture, Beltsville, Md.).

From Tropical rain forest.

A survey of seedlings was made of the El Verde study areas after the Radiation Center was irradiated. Tabebuia heterophylla seedlings were dominant because a nearby parent tree had flowered during irradiation and produced a swarm of seedlings. (auth)

21934 (TID-24270, pp D,193-9) GROWTH AND SURVIVAL OF THE SIERRA PALM UNDER RADIATION STRESS IN NATURAL AND SIMULATED ENVIRONMENTS. McCormick, J. Frank (North Carolina Univ., Chapel Hill. Dept. of Botany).

From Tropical rain forest.

Population samples of the sierra palm, Euterpe globosa Gaertn., were exposed to varying intensities of radiation in their natural rain forest environment and also in simulated growth chamber and greenhouse environments. Survival under field conditions compared favorably with predictions based on nuclear-volume measurements. Palm seedlings were more sensitive to acute than chronic exposures under simulated conditions. Exposures in excess of 35 kr would be required to severely damage populations of this dominant species. (auth)

21935 (TID-24270, pp D,201-11) DIRECT AND INDIRECT EFFECTS OF GAMMA RADIATION ON SEEDLING DIVERSITY AND ABUNDANCE IN A TROPICAL FOREST. McCormick, J. Frank (North Carolina Univ., Chapel Hill. Dept. of Botany).

From Tropical rain forest.

Studies were made of seedling density, diversity, and microenvironmental conditions in 90 1-m^2 quadrats in the Radiation and South Control Centers at El Verde before and after irradiation. Prior to irradiation an increase in diversity toward the center of the Radiation Center was observed which may be accounted for by human disturbance, especially trampling. Following irradiation, as the more radiosensitive species disappeared, species diversity was reduced in proportion to the radiation exposure. Seedling density increased in an area that had received in excess of 35 kr, the populations initially consisting of a single species, Palicourea riparia. Studies of growth of Palicourea seedlings were made in growth chambers. Palicourea benefitted from increased light intensity and temperatures in the forest following irradiation. (auth)

21936 (TID-24270, pp D,213-25) BRYOPHYTE STUDIES ON THE IRRADIATED AND CONTROL SITES IN THE RAIN FOREST AT EL VERDE. Steere, William C. (New York Botanical Garden, N. Y.).

From Tropical rain forest.

Bryophytes were more resistant to ionizing radiation than higher plants. Among bryophytes, leafy hepatics were most sensitive and mosses were most resistant. Fissidens garberi is the most resistant of all since it survived within 10 m of the cesium source and within 3 m in somewhat shielded localities. (P.B.M.)

21937 (TID-24270, pp D,227-31) A STUDY OF THE LICHENS OF AN IRRADIATED RAIN FOREST. Gannutz, T. P. (Clark Univ., Worcester, Mass. Dept. of Biology).

From Tropical rain forest.

The lichen population of a tropical rain forest community was examined, and the effects of ionizing radiation on the lichen thalli were determined. Although the rain forest environ does not, a priori, seem favorable for the formation of a lichen symbiosis, abundant lichens of the crustose type growth form inhabit the area. None of the lichens survived a total dose in excess of 1×10^6 R; however, a total dose of 3.1×10^5 R was required to produce a 50% reduction in the numbers of thalli as compared to the controls. This supports the thesis that the crustose type lichens are more resistant to radiation than other forms of lichens. (auth)

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21938 (TID-24270, pp D,233-6) DISTRIBUTION OF EPIPHYTIC ALGAE ON PALM FRONDS. Watson, Robert (Georgia Univ., Athens. Dept. of Botany).

From Tropical rain forest.

Epiphytic algae (Phycopeltis, Strigula, and Trentepohlia) on the fronds of the palm Euterpe globosa were studied in the rain forest program of El Verde. Considerable variation in epiphytic algae was attributed to the indirect radiation effect of a sunny microenvironment rather than to the direct effect of radiation. Study of epiphytes on palm fronds of different ages showed a succession from almost no colonies on the innermost young frond to a maximum on the fourth or fifth frond at about 2.5 years of age. Older fronds lost colonies with almost none on the dead outer fronds, four years old. (auth)

21939 (TID-24270, pp D,237-69) PHENOLOGICAL STUDIES OF TREES AT EL VERDE. Pinto, Alejo Estrada (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

From 1963 to 1967 field notes and three series of regular counts were made in study areas at El Verde to outline the patterns of flowering, fruiting, and leaf fall of 60 principal tree species in normal forest and in areas subjected to γ irradiation. (P.B.M.)

21940 (TID-24270, pp D,271-86) LEAF GROWTH, LEAF SURVIVAL, LEAF HOLES, COLOR OF CAMBIUM, AND TERMINAL BUD CONDITION. Mercado, Nelson (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Following γ irradiation of the rain forest plot at El Verde, 10,000 branches were examined in the zones from the source to 30 m and at a 160 m radius. Data were obtained on bud condition, cambium condition, percentage of leaf survival, rate of new leaf production, and leaf holes. These indexes were related to dosage and were used to rank the species according to sensitivity ranging from Euterpe, Sloanea, and Inga laurina with demonstrable damage at 10 kr to Palicourea riparia with demonstrable growth and life at 350 kr. The order of sensitivity of the species varied with the property. Although Palicourea was one of the most resistant in developing new growth, it was also one of the most sensitive in dropping leaves in response to radiation. Species sensitivity was not closely related to nuclear volume. (auth)

21941 (TID-24270, pp D,287-94) BRANCH ELONGATION AND THE RADIATION FIELD. Watson, Henry (Puerto Rico Nuclear Center, San Juan).

From Tropical rain forest.

Five thousand limb tips of ground story plants were tagged and measured in the Radiation and South Control Centers of the El Verde forest after irradiation by the 10,000 curie cesium source. Elongation was again measured on each branch after a 4 mon growth period. Growth was plotted as a function of distance from the source for each species. Limb tips near the Radiation Center with dosages greater than 20 kr subsequently died. Maximum growth was observed in the zone from 10 to 18 m where dosage accumulation was 4.5 to 9.5 kR but where bright light was entering from the open canopy above the source. Growths in the South Control Center were small. The dosage at which growth in the Radiation Center equaled that in the Control Center was taken as a measure of species sensitivity. Palicourea riparia was most resistant. (auth)

21942 (TID-24270, pp D,295-8) EFFECT OF GAMMA RADIATION ON CHLOROPHYLL A CONTENT IN BROMELIADS. Koo, F. K. S.; Odum, H. T.; De Irizarry, Edith Robles (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Chlorophyll A and optical transmission density of leaves were measured in Guzmania berteroniana (bromeliads) which were removed from the El Verde forest, irradiated with γ radiation from a ^{60}Co source, and retained in moderate illumination in a greenhouse. Chlorophyll and optical transmission density of leaves declined in the 60 days following irradiation with more decrease in plants receiving 75 kR or more. Significant correlation was found between chlorophyll A and transmission density of the leaves. (auth)

21943 (TID-24270, pp D,299-303) RADIATION EFFECT ON SURVIVAL AND GROWTH OF BROMELIADS. Koo, F. K. S.; Venator, R. C. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

The survival and growth of Guzmania berteroniana bromeliads were studied in relation to γ irradiation with acute doses applied under greenhouse conditions and 3 mon doses in the natural rain forest environment at El Verde. Bromeliads were resistant with 85% of the plants surviving acute radiation of 48 kR. In the field after 2 years, 33% had survived 33 kR. New growth centers developed at 7.7 kR. (auth)

21944 (TID-24270, pp D,305-8) VEGETATIVE SPROUTING FOLLOWING IRRADIATION OF A TROPICAL RAIN FOREST. Jordan, Carl F. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

The importance of vegetative sprouting was studied in the El Verde Radiation Center 18 mon after γ irradiation. Sprouting was less important in the recovery of the irradiated tropical rain forest in Puerto Rico from a short period of radiation than it was in the recovery of a temperate forest in Georgia. In the tropical montane rain forest, most of the roots are on the soil surface and thus are directly exposed to radiation, whereas in the Georgia forests roots are shielded by soil. Sprouting at El Verde usually occurred only where there was shielding by rocks or soil. Sprouting occurred in a relatively narrow band 5 to 15 m in radius surrounding the radiation source and usually on the side of the tree facing the source. (auth)

21945 (TID-24270, pp D,309-11) HEMISPHERICAL PHOTOGRAPHS AT EL VERDE. Johnson, Philip L. (Georgia Univ., Athens. Inst. of Ecology).

From Tropical rain forest.

Hemispherical photographs of the canopy are given for the radiation source and for a site 10 m southeast of the source on Feb. 7, 1965 (during irradiation), and on Jan. 23, 1966, a year later. Canopy closure index decreased about 10% in the first year and was about 50% diminished by the end of the second year. (auth)

21946 (TID-24270, pp F,9-13) FLESHY FUNGI IN RELATION TO IRRADIATION AND CUTTING IN THE LUQUILLO EXPERIMENTAL FOREST. Cowley, G. T. (South Carolina Univ., Columbia. Dept. of Biology).

From Tropical rain forest.

During late July and early August of 1964, surveys of fleshy fungi were made within a 30 m radius in the Radiation and South Control Centers. In 1965, after irradiation, similar surveys were made in these same two centers and within a 10 m radius in the North Cut Center. Before irradiation there were no clear differences between populations in the Radiation and South Control Centers. After irradiation of the Radiation Center, the populations in the part of this center where the canopy was opened and those in the North Cut Center differed from the populations in the South Control Center and from each other. It was suggested that the changes in fungi populations were due to increased exposure resulting from opening of the canopy and to the differences in available substrate rather than to direct effects of radiation. (auth)

21947 (TID-24270, pp F,25-8) EFFECT OF RADIATION ON THE MICROFUNGAL POPULATIONS OF SIX LITTER SPECIES IN THE LUQUILLO EXPERIMENTAL FOREST. Cowley, G. T. (South Carolina Univ., Columbia).

From Tropical rain forest.

Populations of microfungi on the litter of six common trees of the Luquillo Experimental Forest were isolated from two study centers before and after irradiation of one of the centers. Before irradiation a relatively high degree of similarity was noted between populations of microfungi on like litter species in the two centers. Considerably less similarity existed between populations on unlike litter species regardless of the center. After irradiation of one center, the similarity between populations on like litter species in the two centers was no greater than that of populations on unlike species. A decrease in the incidence of dark-pigmented microfungal species was noted in the irradiated center. (auth)

21948 (TID-24270, pp F,35-9) RESPONSE OF SOIL, ROOT, AND LITTER MICROFUNGAL POPULATIONS TO RADIATION. Holler, James R.; Cowley, G. T. (South Carolina Univ., Columbia. Dept. of Biology).

From Tropical rain forest.

Microfungal populations were isolated from the soil, root, and litter layers in both the Radiation and the South Control Centers of the Rain Forest Project before irradiation in the summer of 1964 and after irradiation in the summer of 1965. After irradiation the similarities between comparable layers in the two centers were reduced 14 to 18%. The total population in the soil of the Radiation Center after irradiation was significantly higher than that of the South Control Center, and the litter population of the North Cut Center was significantly higher than all other populations. Diversity of soil and litter populations

was greatest in the South Control Center; the root populations were most diverse in the North Cut Center. (auth)

21949 (TID-24270, pp G.15-20) NUCLEAR VOLUME AND RADIOSENSITIVITY OF PLANT SPECIES AT EL VERDE. Koo, F. K. S.; De Irizarry, Edith R. (Puerto Rico Nuclear Center, San Juan).

From Tropical rain forest.

The nuclear volumes of 68 plant species of the rain forest at El Verde were studied. The measurements ranged from 23.6 μ^3 for Miconia tetrandra to 335.6 μ^3 for Smilax coriacea. As a group the species studied fell in the lower range of nuclear volume measurements, compared with other groups of known species. The actively growing meristems always had much larger nuclei than dormant or slow growing meristems of the same species. The 100% growth inhibition dose observed for twigs appears to agree with the predicted inhibition dose in the majority of instances although these species as a whole tend to be more resistant than predicted. The species that do not agree well with expectations may have high chromosome numbers or be of a different plant type. (auth)

21950 (TID-24270, pp G.21-38) INHERENT AND RADIATION-INDUCED CYTOLOGICAL ABNORMALITIES IN PALICOUREA RIPARIA BENTH. Venator, Robert; Koo, F. K. S. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Cytological studies were made of Palicourea riparia Benth., a small tree dispersed within the γ radiation field of the rain forest at El Verde, Puerto Rico. Under natural conditions this species was found to have a relatively high frequency of cytological abnormalities including univalents, nonseparating bivalents, micronuclei at meiosis, cytomixis, binucleate pollen mother cells, polyspory, etc. After 3 mon of chronic γ irradiation, there was a significant increase in meiotic abnormalities, such as lagging univalents (including chromosome fragments), lagging bivalents, and micronuclei. These abnormalities increased as the dose increased. The abnormality frequencies decreased with a passage of time. Pollen abortion was surprisingly low in view of the high doses received by the trees close to the radiation source; the added stress of ionizing radiation had a very limited effect upon the reproduction and survival of P. riparia. The high resistance of this species to radiation may be attributed to the small chromosome volume and reduplication of chromosomes of this polyploid species. (auth)

21951 (TID-24270, pp G.63-7) HISTOLOGICAL DAMAGE INDUCED BY GAMMA IRRADIATION IN SHOOT APICES OF PALICOUREA RIPARIA. De Irizarry, Edith R.; Koo, F. K. S. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

The apical meristem of Palicourea riparia was studied cytologically and histologically. The effects produced by a 92 day irradiation on the meristematic tissues include plasmolysis, cell vacuolation, changes in the division plane, disorganization and disintegration of cells and tissues, indentation or invagination of the meristem, regeneration of new meristem, and formation of wound tissues. In general, it appears that the outer region was more sensitive to radiation than the inner region and that radiation injury increased with the dose. It was also observed that the meristems collected 1 to 3 mon following the completion of irradiation exhibited less damage than the ones collected 11 to 13 mon after irradiation. (auth)

21952 (TID-24270, pp I.81-102) PHOTOSYNTHETIC STUDIES ON FOUR SPECIES OF RAIN FOREST SEEDLINGS. Lugo, Ariel (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Photosynthetic studies were made on seedlings of the rain forest species Cecropia peltata, Anthocephalus cadamba, Sloanea berteriana, and Dacryodes excelsa under various light conditions using a Beckman infrared carbon dioxide analyzer. Cecropia peltata and Anthocephalus cadamba were classified as sun plants with a high maximum rate of net photosynthesis of 0.30 and 0.29 g C/m^2/hr, respectively. Sloanea berteriana and Dacryodes excelsa were classified as shade plants with a lower maximum rate of net photosynthesis (0.14 and 0.06 g C/m^2/hr, respectively. The sun adaptation of C. peltata and A. cadamba permits their rapid growth as successional species when bright light conditions develop following landslides, cutting, or ionizing radiation. The shade adaptation of D. excelsa and S. berteriana permits their survival for long periods within the forest canopy until some intermediate light promotes some growth. A study of tagged D. excelsa seedlings after irradiation showed greater development on steep slopes than on flat locations and greater survival in the well-lighted areas around the Radiation Center than in the South Control Center. (P.B.M.)

21953 (TID-24270, pp I.103-64) METABOLISM AND EVAPOTRANSPIRATION OF SOME RAIN FOREST PLANTS AND SOIL. Odum, H. T.; Lugo, A.; Cintron, G.; Jordan, C. F. (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

The metabolic rates of some principal forest components were measured with CO_2 analyzer methods; these components included sun and shade leaves of some principal trees, the forest floor, roots, trunk surfaces, and some animals. The calculated net photosynthesis of 1.14% per day compared with the weighed accumulation rate of 1.03% dry weight per day. The controlling limits of airflow on respiration and photosynthetic rates were studied. The asymptotic limiting factor graph of leaf photosynthesis and rate of airflow showed little change above about 4.5 m/min. Successional species had net photosyntheses of 0.1 to 0.6 g C/m^2/hr and respiration rates of 0.01 to 0.4 g C/m^2/hr, which were highest when growth was taking place. In sun leaves of climax trees, net photosynthesis was mainly 0.05 to 0.32 g C/m^2/hr, and night respiration was 0.01 to 0.05 g C/m^2/hr in nongrowing mature leaves. In shade leaves net photosynthesis was 0 to 0.1 g C/m^2/hr and night respiration, 0.04 to 0.12 g C/m^2/hr. The rates of trunk surface respiration and photosynthesis in daytime were 0.045 and 0.025 g C/m^2/hr, respectively. The respiration of small root clusters was determined in situ with plastic sleeves wrapped around roots. The average respiration was 0.23 g C/hr/kg dry weight. When very high abnormal airflows were drawn through the sleeves, rates 10 times higher were found. The forest floor respiration rate was found to increase in proportion to airflow without limits within any airflow rates possible within the forest. High metabolic rates in fast flushing chambers and under foils were sustained for weeks indicating that the high rates were due not to drain of storages but to augmented respiration rates. Wide ranging surges of carbon dioxide discharge from the soil were measured and associated with eddies in the air above. Transpiration was measured as 96 to 800 g water/m^2 of leaf area/day varying sharply from one day to another with regimes of light and dry air. (P.B.M.)

21954 SEQUENTIAL RESPONSE TO GROWTH SUBSTANCES IN COLEOPTILES FROM γ IRRADIATED WHEAT. Rose, R. J.; Adamson, D. (Macquarie Univ., North Ryde, Australia). Planta; 88: 274-81(1969).

Gamma-irradiated wheat seed (500 kr) produces coleoptiles that grow without cell division or DNA synthesis. Apart from an initial 24-hr delay in growth, intact γ coleoptiles have a pattern of cell elongation similar to normal coleoptiles. The elongation of coleoptiles excised at a size of 2 mm, when the cells are small and just prior to entering a rapid elongation phase, is promoted by kinetin and gibberellic acid (GA_3). Elongation of coleoptiles excised at 8 mm, when the cells are larger and in the rapid elongation phase, is promoted by indoleacetic acid (IAA). This sequential response to growth substances in γ coleoptiles is remarkably similar to that in normal coleoptiles. The GA_3 response in excised γ coleoptiles is not inhibited by FUDR, confirming that DNA synthesis is not required for GA_3-induced elongation in γ coleoptiles. (auth)

21955 HEAT- AND X-RAY INDUCED INHIBITION OF SELF-INCOMPATIBILITY IN LILIUM LONGIFLORUM. Hopper, James Ernest. Madison, Wis.; Univ. of Wisconsin (1970). 87p. University Microfilms Order No. 70-13,917.

Thesis.

Self-incompatibility among angiosperms is an outbreeding system whereby identical genetic specificities in pollen and pistil dictate a failure in seed production following self pollination. Neither the physiology nor the biochemistry underlying this failure is understood, although the genetics of the system have been known for some time. Lilium longiflorum is especially suitable for studies concerned with the mechanism of the self-incompatibility reaction. Heat shock, x rays, and autoradiography were used in an attempt to further characterize the development and physiology of the stylar component of the self-incompatibility expression. Treatment of the style with either a short, moderate heat shock, or a moderately high dose of x rays inactivates the self-incompatibility. Immersion of the unpollinated style in 49°C water for five min, or x irradiation with doses from 28 to 70 kr, allows incompatible pollen tubes to traverse such styles at a greatly increased rate closely approaching that of compatible pollen tubes. The incompatible tubes growing through these treated styles do reach the ovary and function in fertilization, as shown by seed production. Increasing the duration of heat treatment from 0 to three mins, or increasing the x ray dose from 2 to 28 kr, results in an increasing per cent inactivation of the stylar incompatibility function. The kinetics of the heat induced inactivation reflect a 25% inactivation per minute during the first 3 mins of stylar im-

XUM

mersion in 49°C hot water. This indicates an extreme sensitivity of the stylar incompatibility function to heat at that temperature. The use of heat shock as a precise means of turning off the stylar incompatibility function in alternate sections of a style or at different times during stylar development offers a systematic approach to future studies on the biochemistry and physiology underlying the development and expression of self-incompatibility in Lilium longiflorum. (Diss. Abstr. Int., B) (TSS)

21956 IRRADIATION OF SUNFLOWER AND BARLEY SEEDS BEFORE SOWING. Riza-Zade, R. R.; Suleimanova, N. L.; Tagiev, A. T. Izotopy SSSR; No. 18, 50(1970). (In Russian).

Experiments on pre-sowing irradiation of the Armabirsk 3497 type sunflower and Nakhichevandy type barley showed that a 2000 R dose stimulates the growth of sunflower and 300 R the growth of barley. The sunflower and barley plants grown from γ-irradiated seeds exceeded the control plants in quantity and quality. Gamma doses of 2000 R and 300 R are recommended for mass growth of sunflower and barley, respectively. (R.J.V.)

21957 BIOLOGICAL THRESHOLDS FOR MUTAGENIC INFLUENCE ON PLANTS GERMINATED FROM IRRADIATED SEEDS (THE CASE OF FINE-FIBRED COTTON). Konoplya, S. P.; Fursov, V. N. Izv. Akad. Nauk Turkm. SSR, Ser. Biol. Nauk; No. 2, 70-4(1970). (In Russian).

Dry seeds of 18 cotton varieties were investigated after x irradiation. In accord with typical varieties, which indicated maximum and minimum points, thresholds of biological influence of γ radiation were determined on Gossypium barbadense. The distribution of thresholds dose for mutagenesis was determined. (auth)

21958 EFFECT OF ACUTE GAMMA RADIATION ON THE INTERNAL LEAF STRUCTURE IN PERILLA OCYMOIDES L. Kashina, T. K.; Savin, V. N. (Agrophysical Scientific-Research Inst., Leningrad). Bot. Zh.; 55: 537-49(1970). (In Russian).

The influence of acute γ irradiation on the internal leaf structure was studied using Perilla ocymoides leaves treated with 360 R/min of ^{60}Co γ radiation. It was found that the radiosensitivity of the Perilla leaf blade was higher than that of the main vein of the leaf. Differentiation of the leaf mesophyll tissue and of the phloem strands of the main vein was inhibited. (R.V.J.)

21959 STUDIES ON THE RADIATION BREEDING IN THE GENUS MENTHA. 7. THE SENSIBILITY TO RUST IN RADIATION-INDUCED VARIATION OF JAPANESE MINT. Ono, Seiroku; Ikeda, Nagamori (Okayama Univ., Japan). Okayama Daigaku Nogakubu Gakujutsu Hokoku; No. 35, 7-10(Mar 1970). (In Japanese).

Dry seeds of Japanese mint were exposed to acute ^{60}Co γ irradiation and x irradiation. The total doses of 10 kR and 20 kR with the dose-rate of 50 R/min were employed. X_2 populations from the irradiated seeds showed a different sensibility to rust disease from the nonirradiated population of Japanese mint, and a large number of the plants had a high resistance to rust disease. Progeny tests were carried out on the selected high resistant individuals in the X_2 populations and it was found that their X_3 populations arranged themselves close to the normal distribution as to the degree of sensitivity to rust disease. It was concluded that a number of multiple genes or polygenes participate in the determination of the susceptibility to rust disease in Japanese mint. Exposure to ^{60}Co γ rays was more effective in producing mutants with high resistance to rust disease than exposure to x rays. (auth) (Japan)

21960 METHODS FOR PROTECTION AND RECOVERY OF PLANTS DAMAGED WITH IONIZING RADIATION. Grodzinskii, D. M.; Gudkov, I. N. (Inst. of Plant Physiology, Kiev). Fiziol. Biokhim. Kul't. Rast.; 1: 147-56(1969). (In Russian).

The different methods of recovery of plants from radiation injuries (reparation, regeneration, and compensatory) are reviewed. Different methods of protection of plants (physical and chemical, reparation and regeneration, genetic and somatic protection with preradiation application of radioprotectors and recovery in post-radiation period) are discussed. Particular attention is paid to regeneration of plants during the post-radiation period and to the role of apical dominance in this process. The modern methods for recording radiation damage, protection, and recovery of plants are elucidated. (auth)

21961 STUDIES ON THE RADIATION BREEDING IN THE GENUS MENTHA. 6. DOSE-RESPONSE CURVE FOR ROOT GROWTH AND INTERSPECIFIC DIFFERENCE IN RADIOSENSITIVITY. Ono, Seiroku (Okayama Univ., Japan). Okayama Daigaku Nogakubu Gakujutsu Hokoku; No. 35, 1-6(Mar 1970).

The dormant seeds of twenty species or lines in the genus Mentha (mint) irradiated with 5 kR to 60 kR of ^{60}Co gamma ray were allowed to germinate on the water soaked blotting paper in petri dishes. The result of measurement on the length of seminal roots 20 days after the irradiation showed large difference in radiosensitivity between the species of Mentha. All their dose-response curves can be approximated by the following general function: $A_r = 1 - (1 - e^{-KD})^4$ where A_r is the ratio of mean root length to the corresponding control value, D is dose and K is a characteristic value for each species. The radiosensitivity of a species can be expressed only by the value K in the function irrespective of dose used, and K represents quantitatively the level of radiosensitivity. The interspecific difference as much as maximum four times is observed in the radiosensitivity of twenty species or lines, and the clear difference in radiosensitivity distribution between two subgenera was observed. (Japan)

21962 EFFECTS OF GAMMA RADIATION ON GERMINATION AND SEEDLING DEVELOPMENT OF MULBERRY. Das, B. C. (Central Sericultural Research Station, West Bengal, India). Sci. Cult. (Calcutta); 36: 60-1(Jan 1970).

Dry seeds of Morus alba var. Ichinose were irradiated with 2.5, 5.0, 7.5, 10.0 and 15.0 kR of Co-60 γ radiation at a dose rate of 5 kR/hr. The seeds were allowed to germinate and the survival of seedlings was noted. Measurements of root length and shoot height were recorded for the remaining plants. The germination percentage was found to be higher for irradiated seeds than for controls. The survival of transplanted seedlings decreased with increased dosage and at 15 kR there was no survival of transplants. Seedling height and root development diminished with increased radiation dose. (F.M.M.)

21963 EFFECT OF GAMMA IRRADIATION ON THE FREQUENCY OF CHROMOSOME ABERRATIONS IN POTATO SEEDS (SOLANUM TUBEROSUM L.). Mezentsev, A. V. (Research Inst. of Potato Husbandry, Moscow). Genetika; 6: No. 11, 52-6(Nov 1970). (In Russian).

Different potato seeds were irradiated by ^{60}Co in doses of 10, 20, and 30 kR at an output of 50, 500, and 5000 R/min. Chromosome aberrations in the anaphase of the first mitosis were registered. It was found that the number of aberrations increased with the increase of irradiation dose and depended on genotype of experimental material. The curve of aberration dependency on the irradiation dose was also typical for saturation. Hybrids were more resistant to irradiation as compared with the self-pollinated seeds. (auth)

21964 RELATIVE BIOLOGICAL EFFECTIVENESS OF MULTICHARGED IONS DURING SINGLE IRRADIATION OF CHLORELLA. Vekshina, L. K.; Kogan, I. G.; Kudryashov, E. I.; (and others). Kosm. Biol. Med.; 4: No. 5, 39-42(Sep-Oct 1970). (In Russian).

The dose dependence of relative biological effectiveness of accelerated C-12 ions was found. An increase in the inactivation cross-section with an increase at the linear energy transfer of ionizing radiation was found. A dose-dependent change in Chlorella mutability was observed. (auth)

21965 EURATOM-I.T.A.L. ASSOCIATION. De Zeeuw, D. (EURATOM-ITAL Association, Wageningen, Netherlands). Energ. Nucl. (Paris); 12: 524-8(Nov-Dec 1970). (In French).

The aims of the research program are to increase food production and quality, and to ensure that the food storage is financially feasible. Radiation effects inducing mutations in plants are considered from the point of view of present day requirements. The application of new nuclear techniques allows the physiological mechanism of the plants and the factors having an effect on the plant growth and breeding to be investigated. The use of radiations in order to increase the storage duration of fresh and tinned food was studied. (auth) (France)

21966 EFFECTS OF CYTOQUININE ON THE LEAVES OF NICOTINIA RUSTICA EXPOSED TO X RADIATION. Sveshnikova, I. N.; Dezhi, L.; Bolyakina, Yu. P.; Kulaeva, O. N. (Timiryazev Inst. of Plant Physiology, Moscow. Univ. of Budapest). Dokl. Akad. Nauk SSSR; 193: 706-8(21 Jul 1970). (In Russian).

Cytoquinine retards the yellowing of cut leaves by preventing the breakdown of the metabolism and structural organization of cells. Earlier tests indicated that exposure of tobacco leaves to 5 to 100 kR of γ radiation did not prevent the leaves to react with cytoquinine. Leaves with 15 cm radius disks cut out were exposed to 25 kR of x radiation, then placed in a humid chamber and exposed to fluorescent light at 24 to 25°C, sprinkling them daily with a 20 mg/l solution of 6-benzyl aminopurine (BAP). The disks were tested to determine the incorporation of ^{14}C-

leicin in the albumin. It was found that the irradiation strongly depresses the incorporation of the labeled compound, supporting the findings of other authors. The cytoquinine strongly stimulated the albumin synthesis of the irradiated and the central specimens; BAP also affected strongly the structural organization of the chloroplasts of irradiated leaves. The most important conclusion is that the high level irradiation did not prevent the action of cytoquinine on the metabolism of the leaves. (TTT)

21967 MECHANISM OF THE INTENSIFIED GROWTH OF LATERAL SHOOTS OF IRRADIATED PLANTS. Savin, V. N.; Stepanenko, O. G. (Agrophysical Scientific Research Inst., Leningrad). Dokl. Akad. Nauk SSSR; 193: 929-31(1 Aug 1970). (In Russian).

The overall increase of the productivity of irradiated plants was found to be related both to the enhanced growth of lateral shoots and the retarded growth of the main stem. This stimulation might be due to the decrease apical dominance and to disturbances in the growth correlations. This assumption was further examined on the medicinal peppermint plant, exposing the specimens to total irradiation by γ rays of a ^{60}Co source at doses of 3, 5, and 7 kR; and total or localized irradiation by 6 kR of x radiation. The results confirmed that the radiostimulation of the plants is due to disturbances of growth correlations, whereby the top buds are retarded and the apical dominance is decreased; the continuing photosynthesis leads to an accumulation of the feed materials in the leaves and to the increased removal at the growing points of the lateral shoots, resulting in their enhanced growth rate. (TTT)

21968 MODIFICATION OF THE EFFECTS OF X-RAYS BY MEANS OF GUANINE, METHYLENE BLUE, AND ANTIBIOTICS. Langer, I. Genet. Slechteni; 6: 269-74(Nov 1970). (In Czech).

The modification effects of guanine, methylene blue, penicillin G, and of streptomycin on the physiological and genetic effect of x radiation in summer barley were investigated. The substances were applied to the seed before the radiation for 30 hr at a temperature of 20°C. In the M(1) generation the height of young plants, the weight of their overground parts, the weight of the dry substance, the mortality, and the sterility of the principal ear were investigated. In the M(2) generation the frequency of chlorophyll mutations was determined. In the M(1) generation guanine showed protective effects, in the M(2) generation the frequency of chlorophyll mutations increased 1.74 times. Methylene blue increased the unfavorable effect of radiation in the M(1) generation, but, simultaneously, the frequency of chlorophyll mutants in the M(2) generation increased (2.36 times). In the M(1) generation penicillin showed no protective effects, and in the M(2) generation it lowered the frequency of chlorophyll mutants 1.62 times. Also, no protective effect in the M(1) generation was obtained after streptomycin treatment, but in the M(2) generation the frequency of chlorophyll mutants increased 2.00 times. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 21577 and 21663.

21969 (TID-24270, pp F,29-33) ASPECTS OF SOIL MICROFLORA IN A GAMMA-IRRADIATED RAIN FOREST. Witkamp, Martin (Oak Ridge National Lab., Tenn.).

From Tropical rain forest.

Microbial densities and activity were measured just before and after 3 mon of irradiation and again 7 and 13 mon after the period of γ irradiation. In April, immediately after irradiation, the freshly fallen litter increased organic matter, moisture content, bacterial density, CO_2 evolution, and O_2 uptake in the defoliated area within 20 m from the source. Maximum microbial activity at that time was located near the periphery of the defoliated area because of the usual microbial bloom on freshly fallen litter. One year after irradiation bacterial densities and activities in the defoliated area had dropped below those in the forest with leaves remaining, presumably as a result of substrate exhaustion and lack of additional litter deposition. (P.B.M.)

21970 (TID-24270, pp F,57-65) A STUDY OF NATURAL VIRUS CYCLES BEFORE, DURING, AND AFTER IRRADIATION. Weinbren, M. P.; Weinbren, B. M. (Atomic Energy Board, Pretoria (South Africa)).

From Tropical rain forest.

A study of viruses was made in the populations of Rattus rattus and in 10 species of mosquitoes in the rain forest at El Verde in the year preceding and following γ irradiation. No arboviruses were found, but Coxsackie virus was found in rats and mosquitoes immediately following irradiation. A few Aedes aegypti were found within the forest. (auth)

21971 (TID-24270, pp F,67-8) SURVIVAL OF ACTINOMYCETES IN A RADIATION FIELD. Perry, Jerome J. (North Carolina State Univ., Raleigh. Dept. of Microbiology).

From Tropical rain forest.

Actinomycetes were isolated from the soil in an area of the rain forest before and after irradiation. Organisms were also isolated from the soil of the South Control Center at the same time. Quantification of the actinomycetes present in the soil suggests that there was some decrease in the total number after irradiation, which may be a secondary effect. No damage was evident in the microbes present after irradiation as measured by growth and metabolic activity. (auth)

21972 (TID-24270, pp G,3-14) MICROSCOPIC ORDER IN THE FOREST. Odum, Howard T. (North Carolina Univ., Chapel Hill).

From Tropical rain forest.

From cytological and ecological data, radiation is found to be a control agent on the flows of energy in growth, reproduction, and maintenance of the complex ecological network in which sharp selective control actions override the effects that might be predicted from radiation action on protoplasm alone. Dosage response curves resemble energy washout predictions. The microscopic order is as much dependent on the homeostasis of the macroscopic organization of light fields, consumer control species, energy reserves for repair, and regenerative mechanisms as vice versa. The green forest attains a quiet order at the macroscopic level even though it is a seething, selecting, noisy struggle with much error at the microscopic level. (auth)

21973 (TID-24270, pp I,35-56) METABOLISM OF FOREST-FLOOR MICROCOSMS. Odum, Howard T.; Lugo, Ariel (Puerto Rico Nuclear Center, Rio Piedras).

From Tropical rain forest.

Terrestrial microcosms were seeded in plastic desiccators with mineral soil, litter, forest floor herbs, and small animals to simulate some properties of the rain forest floor. After a year of acclimation to conditions of the forest floor, diurnal records of photosynthesis and respiration were made with a carbon dioxide analyzer operating as a closed system. The efficiency of gross photosynthesis ranged from 1 to 3.2% of visible light incident. The gaseous balance between photosynthesis and respiration was found at different mean carbon dioxide levels (200 to 2000 ppm) with diurnal ranges from 200 to 1000 ppm/day. Compared to control systems total metabolism of irradiated microcosms was little affected by 3 mon exposure to 25,000 R. The principle established for aquatic microcosms that respiration is at maximum at the end of the light period and maximum photosynthetic efficiency at the end of the dark period was confirmed for the terrestrial microcosms also. Data thus support the model of control of respiration and photosynthesis by limiting flow from one process, depending on the recent storage accumulating from the other process. (auth)

21974 EFFECTS OF γ RADIATION ON THE TOXIN OF CLOSTRIDIUM BOTULINUM TYPE A. Sehgal, Lakshman Raj. Chicago; Illinois Inst. of Tech. (1970). 126p. University Microfilms Order No. 70-22,782.

Thesis.

A high specific activity and a sensitive animal assay for type A toxin of C. botulinum make it a useful protein to study the mechanism of radiation resistance of spores and spore proteins. The first series of experiments were done to determine the molecular weight of the toxin in situ in spores, vegetative cells, and the spent culture medium, using the target theory. Irradiation was carried out in the dry state, in Pork Pea broth, and in phosphate buffer. The average molecular weight obtained was 120,000 ± 44,000. Radiolysis of the pure A_α toxin in acetate buffer was carried out, and changes in the molecule were observed by ultracentrifugation, gel filtration, and acid gel electrophoresis. Inactivation of the toxin was measured by animal assay. The A_α toxin was irradiated in the dry state and the ensuing changes were observed by ultracentrifugation. In this case, only a small increase in the $S_{20,w}$ value was noted initially with only 30% loss in activity; on further irradiation $S_{20,w}$ values decreased from 7.0 for the native toxin to 1.54 for the toxin receiving 4.0 Mrads with concomitant loss of activity. The effects of scavengers (O_2, N_2O, ethanol) on the radiosensitivity of A_α toxin in acetate buffer at pH 4.2 was studied. Results indicated that the .OH radicals contribute 38% to inactivation, the .H radicals, 48% and e^-_{aq}, 14%. Almost complete protection was obtained when irradiation was carried out in the presence of ethanol and oxygen. A mechanism for the radioprotection of the toxin in spores is proposed

on the basis of the finding that the toxin irradiated in situ was comparable to the pure A_α toxin irradiated in the dry state. (Diss. Abstr. Int., B) (TSS)

21975 ULTRAVIOLET MUTAGENESIS IN STRAINS OF E. COLI DEFICIENT IN DNA POLYMERASE. Witkin, E. Nature (London) New Biol.; 229: 81-2(20 Jan 1971).

The pol A locus in some strains of Escherichia coli is a genetic defect in DNA polymerase activity. The percentage survival in strains W81 (pol A) and a pol^+ revertant W82 (pol^+), was measured after exposure to doses of ultraviolet light from 0 to 225 ergs/mm^2. Induced Try^+ mutations were counted per 10^7 survivors. There was a marked difference in survival between the two strains, but the frequency of Try^+ mutations was about the same. The survival and frequency of induced His^+ mutations in strains W79 (pol A) and W80 (pol^+) was also recorded after exposure to 150 ergs/mm^2 of uv light. No significant differences were seen in the frequency of H^+ mutations. The normal uv mutability of pol A mutants was compatible with the assumption that the cause of uv sensitivity was reduced efficiency of a late step in excision repair. (UK)

21976 SURVIVAL KINETICS IN AZOTOBACTER CHROOCOCCUM UNDER THE ACTION OF ^{60}Co GAMMA RAYS AND OF A RADIOSIMULATION AGENT. Goussard, J.; Boige, F.; Kauffmann, J.; Abbatucci, J. S. (Centre Regional de Lutte contre le Cancer, Caen, France). Compt. Rend. Soc. Biol.: 164: 764-7(1 Dec 1970). (In French).

The survival curves of Azotobacter chroococcum exposed to the action of ^{60}Co γ radiation resemble those obtained with a radiosimulation agent, ibenzmethyzin (Natulan), suggesting that Natulan acts in the same way as radiation. The similarity between these curves and those obtained from cells of mammals indicates that the restoration processes are of the same kind in both cases. Future work on bacteria, a material particularly suitable for research on the molecular aspects of biology, will throw further light on the radioresistance and restoration mechanisms observed in cellular systems. (France)

21977 PHENOMENOLOGICAL THEORY OF REPAIR KINETICS OF ULTRAVIOLET IRRADIATED LAMBDA PHAGE. Fornili, S. L.; Cordone, L.; Radman, M. (Univ., Palermo, Italy. CNRS, Gif-sur-Yvette, France). Virology; 43: 422-6(Feb 1971).

A theoretical derivation of survival curves of uv-irradiated λ phage, in different phage–bacterium systems (lacking or possessing excision and/or recombination repair) is presented. The mathematical expressions are satisfactorily fitted with experimental points, and the validity and self-consistency of the model are shown. (auth)

21978 PROTECTION AGAINST LETHAL EFFECTS OF ULTRAVIOLET LIGHT ON ESCHERICHIA COLI BY CAPSULAR POLYSACCHARIDE. Donch, John; Greenberg, Joseph (Palo Alto Medical Research Foundation, Calif.). Mutat. Res.; 10: 153-5(Aug 1970).

Studies of mucoid lon strains of Escherichia coli K 12 showed that these were less uv-radiosensitive than nonmucoid strains carrying the same lon mutation. The nonmucoid state of the transductants resulted in an increase in uv-radiosensitivity in PAM 660 lon class A and PAM 555 lon class B. One interpretation of these results is that mucoid polysaccharide acts as an absorbant of uv, thus protecting the cell from its lethal effect. (P.B.M.)

21979 INACTIVATION OF AVIAN SARCOMA VIRUSES WITH UV LIGHT: A DIFFERENCE BETWEEN HELPER-DEPENDENT AND HELPER-INDEPENDENT STRAINS. Friis, Robert R. (Univ. of Washington, Seattle). Virology; 43: 521-3(Feb 1971).

The following hypotheses are suggested to explain the difference in inactivation rates of the helper-dependent and helper-independent strains: since uv survivors were assayed on different cells, inactivation kinetics could reflect differences of the host cells rather than of the viruses; the two strains differ in antigenicity, host range, and sensitivity to interference; the strains differ in the genetic target responsible for the process of cellular transformation. Experiments were conducted to test the three hypotheses. The experimental data excluded the first two hypotheses and supported the hypothesis that the different inactivation rates reflect fundamental differences in the genetic target. (H.L.W.)

21980 STUDIES ON THE REPRODUCTIVE AND CELL-CONVERTING ABILITIES OF AVIAN SARCOMA VIRUSES. Graf, Thomas; Bauer, Heinz; Gelderblom, Hans; Bolognesi, Dani P. (Max-Planck-Institut fuer Virusforschung, Tuebingen, Ger.). Virology; 43: 427-41(Feb 1971).

In order to study whether or not only a part of the genome of avian sarcoma viruses (ASV) is sufficient for focus formation and/or for virus reproduction two classes of ASV mutants were isolated. A search was made for virus particles which have lost their ability to reproduce but are still able to convert chicken cells; and particles which have lost their ability to convert cells but are still able to reproduce. Particles of the first class were not found. Single foci induced by three ASV strains treated with either hydroxylamine, ^{60}Co-γ-, x-, or uv-rays all produced converting virus. Another ASV strain studied (B77 virus) was exceptional in that hydroxylamine-treated virus induced foci which regressed after subsequent subcultivations. Although these foci revealed no virus detectable in the focus assay, electron microscopic studies showed the presence of C-type particles. In addition three low virus-producing mutants were isolated from the B77 strain, one of which induced the formation of regressing foci. Mutants of the second class were found which, although infectious, do not convert chicken embryo fibroblasts. These nonconverting mutants were obtained from ASV strains of subgroups A and D and have envelope properties similar to their corresponding sarcoma virus strains. A tentative model for the genome of avian sarcoma viruses is proposed. Whereas the whole genome of ASV is needed for the induction of proliferating foci only a part of it is sufficient for the production of virus particles. (auth)

21981 ULTRAVIOLET REACTIVATION AND ULTRAVIOLET MUTAGENESIS OF λ IN DIFFERENT GENETIC SYSTEMS. Defais, M.; Fauquet, P.; Radman, M.; Errera, M. (Univ. Libre, Brussels). Virology; 43: 495-503(Feb 1971).

The lex^+ function is necessary for the induction of clear mutations of bacteriophage λ by ultraviolet irradiation. Ultraviolet reactivation of λ phage is also dependent on the lex^+ function. Ultraviolet mutations are affected to a small extent by the red^+ function of λ phage whereas this function seems to play an important role in the spontaneous mutation process. (auth)

21982 UV-REACTIVATION OF BACTERIOPHAGE λ IN EXCISION REPAIR-DEFICIENT HOSTS: INDEPENDENCE OF RED FUNCTIONS AND ATTACHMENT REGIONS. Radman, Miroslav; Devoret, Raymond (CNRS, Gif-sur-Yvette, France). Virology; 43: 504-6(Feb 1971).

The data show that for relatively low uv doses to lambda phage and to the host cell, three known types of excision-deficient mutants of Escherichia coli K12 exhibit uv-reactivation of lambda phage. The λ cI-857 red-3 phage was uv-irradiated with various doses. Three mutants defective in excision repair showed uv-reactivation. The uv-reactivation factor is the ratio; phage survival fraction on irradiated bacteria/phage survival fraction on unirradiated bacteria. Two combinations of E. coli and lambda mutants were used in experiments on recombination between homologous parts of the uv-irradiated host and phage chromosomes. Results indicated that uv-reactivation occurs as a result of recombination between phage and bacterial chromosomes. (H.L.W.)

21983 STUDIES ON ASIATIC INFLUENZA VIRUSES. VI. THE INFLUENCE OF FACTORS INACTIVATING A_2 VIRUSES ON THEIR ABILITY OF INDUCING INTERFERON IN VIVO. Lobodzinska, Maria; Gilakowska, Alicja; Skurska, Zofia (Inst. of Immunology and Experimental Therapy, Wroclaw. Faculty of Pharmacy, Wroclaw). Arch. Immunol. Ther. Exp.; 17: 731-8(1969).

After intravenous injection of A_2/Wroclaw 11/57 influenza viruses in mice, marked differences in the levels of interferon in the serum and spleens of the mice were observed depending on whether the Ea strain sensitive to γ inhibitor, or the Eb insensitive strain was used. Titers of interferon in the spleens and serum of the mice were invariably higher after induction with the Ea than with the Eb strain. Maximal production of interferon was observed after 4 to 6 hr irrespective of the inductor used. Ea and Eb strains inactivated with heat, uv rays, or by longer storage at temp. 4° were worse inductors than active strains. The Eb strain lost its capacity of inducing interferon much more quickly than the Ea strain. (auth)

21984 RECOMBINATION-DEFICIENT MUTANTS OF COLICINOGENIC SALMONELLA TYPHIMURIUM DETECTED BY THEIR FAILURE TO PRODUCE COLICIN. MacPhee, Donald G. (Stanford Univ., Calif.). J. Bacteriol.; 104: 345-50(Oct 1970).

Survivors of nitrosoguanidine treated cultures of a colicinogenic strain of Salmonella typhimurium were tested for spontaneous production of colicin E1. Of about 1,000 colonies tested, 13 produced

no (or very narrow) colicin zones. Four of these isolated proved to be more sensitive to light, x rays, and methyl methane sulfonate than the parent strain and did not show enhanced production of colicin when treated with mitomycin C (which acts as an inducer on wild type cells). Further studies showed that these isolates were of two classes. Three mutants that were extremely sensitive to uv, failed to show spontaneous release of two temperate phages, and were infertile as recipients in transduction or in an Hfr cross although they accepted an F′ factor normally. These independently isolated mutants were inferred to be recombination deficient; one of them had the additional property of increased spontaneous mutability at two loci. The other colicin nonreleasing isolate was only moderately sensitive to uv, showed enhanced spontaneous release of two temperate phages, and was of approximately normal fertility as a recipient in transduction or conjugation. (auth)

21985 EFFECT OF GAMMA RADIATION ON CARNATION MOTTLE VIRUS IN CRUDE DIANTHUS BARBATUS SAP. Kemp, W. G. (Canada Agriculture, Vineland Station, Ont.). Can. J. Microbiol.; 16: 1374-5(Dec 1970).

The infectivity of carnation mottle virus in crude and clarified sap of Dianthus barbatus was not completely eliminated after exposure to 1000 krad of γ irradiation. In clarified sap, the virus was more sensitive to doses of γ radiation than in crude sap. Loss in infectivity of either of the virus suspensions was not correlated with a corresponding loss in antigenic activity. (auth) (Canada)

Radiosterilization and Radiopreservation

Refer also to abstracts 21658, 21687, 21736, 21822–21824, 21898, and 21965.

21986 (NVO-374-17(Vol.2)) HAWAII FOOD IRRADIATION PROGRAM, RAW DATA APPENDICES FOR THE PERIOD JUNE 1, 1968–JUNE 30, 1969. Dollar, Alexander M.; Hanaoka, Masao; McClish, Gale A. (Hawaii State Dept. of Agriculture, Honolulu); Akamine, E. K.; Moy, J.; Ross, E. (Hawaii Univ., Honolulu, Coll. of Tropical Agriculture); Ohinata, K. (Agricultural Research Service, Honolulu, Hawaii). Jan 1970. Contract AT(04-3)-235. 501p. Dep. NTIS.

Data are summarized on the effects of γ irradiation on physiological processes involved in the ripening of papayas. Data are included on the relationship between radiation dose and treatment methods and physical, chemical, and organoleptic parameters of the stored fruit. (C.H.)

21987 (NVO-374-17(Vol.1)) HAWAII FOOD IRRADIATION PROGRAM FOR THE PERIOD JUNE 1, 1968–JUNE 30, 1969. Dollar, Alexander M.; Hanaoka, Masao; McClish, Gale A. (Hawaii State Dept. of Agriculture, Honolulu); Akamine, E. K.; Moy, J.; Ross, E. (Hawaii Univ., Honolulu, Coll. of Tropical Agriculture); Ohinata, K. (Agricultural Research Service, Honolulu, Hawaii). Jan 1970. Contracts AT(26-1)-374; AT(04-3)-235. 231p. Dep. NTIS.

The primary effort during the period reported was the development of data needed to support a petition to USHEW Food and Drug Administration for clearance of the use of ionizing radiation to treat papaya. Essential data on γ source calibration and biological responses of papaya are reported in detail in the text and supporting appendices. Evaluations of combinations of treatments confirmed that immersion in 120°F hot water for 20 minutes followed by treatment by ionizing radiation at a minimum absorbed dose of 50 to 75 krad is the most desirable combination treatment for shelf-life improvement. Treatment at higher radiation doses increased sensitivity to injury and affected normal surface color development, especially during storage. A shelf-life extension of 3 to 3.5 days was achieved by the combination treatments when compared to non-treated controls. (C.H.)

21988 EFFECTS OF IONIZING RADIATION ON THE INCREASE OF GRAPE JUICE. Frumkin, M. L.; Nakhmedov, F. G. Vinodel. Vinograd. SSSR; No. 1, 53-4(1970). (In Russian).

The influence of ionizing radiation on the yield of grape juice and the quality of wine produced was studied using grapes irradiated by ^{60}Co γ rays with 100, 300, and 5×10^3 rad. The results showed that irradiation with 1 to 5×10^3 rad increased the yield about 9.2% and improved the quality or rather the aroma and the color of wine produced. (R.V.J.)

21989 SOME EFFECTS OF GAMMA RADIATION ON GERMINATION AND STORAGE LIFE OF SEEDS OF EIGHT CROP SPECIES. Justice, Oren L.; Kulik, Martin M. (Dept. of Agriculture, Beltsville, Md.). Proc. Int. Seed Test. Ass.; 35: 697-712(1970).

Air-dry seeds of 8 crops species were irradiated with a ^{60}Co source at doses of 0,5, 10, 20, 40, and 80 krad and subsequently stored at 20°C and ambient relative humidity. Radish and crimson clover seeds were also irradiated at doses up to 500 krad. Subsamples were withdrawn and tested for germination after 0.5, 4.5, 14.5 and 27.0 months. At 10 krad dose radiation damage was apparent for wheat, peanut, bluegrass and onion seeds, but the same dose did not significantly reduce germination of seeds of either of the 8 other crop species. The radiation dose at which germination percent was significantly reduced below the control (0 dose) varied with seed lots of a species; for wheat, sorghum, peanut, bluegrass, and onion the dose was 20 to 40 krad; for corn, 40 to 80 krad; and above 80 krad for radish and crimson clover. Stored seeds of crimson clover and radish which had been irradiated at 5 to 80 krad retained germination up to 27 months (equal to the control). For the other crop species the average loss of germination increased gradually with doses up to 20 krad. At 40 and 80 krad the loss increased very rapidly. Average germination losses for all species except radish and crimson clover over the 27-month storage period were 27.9%, 27.0%, 27.1%, 28.7% and 38.1% for doses of 0, 5, 10, 20 and 40 krad, respectively. Inoculation of seeds with spores of storage fungi had no effect on germination of 5 crop species after 27 months, caused reductions in germination of corn and wheat compared to controls, and produced variable, inconsistent results with onion. An increase in the moisture content of radish seed prior to irradiation (from 5% to 10.5%) significantly reduced radiation damage; a further increase to 13.5% gave no additional reduction. (auth)

21990 INVESTIGATIONS ON THE RADIORESISTANCE OF ANTHOCYANIN PIGMENTS. PART III. EFFECT OF TEMPERATURE AND pH ON THE RADIATION DEGRADATION OF ANTHOCYANINS AND ASCORBIC ACID IN FRUIT JUICES. Wilska-Jeszka, Jadwiga (Politechnika, Lodz, Poland). Nukleonika; 15: 445-54(1970). (In Polish).

The color changes and ascorbic acid losses induced by γ irradiation of liquid and frozen fruit juices were investigated. Doses of 0.2 to 2.5 Mrad were used. The effects of pH from 2 to 6 and temperature ranging from 77 to 293°K were examined. It was found that an increase in pH lowered the losses of anthocyanins, but did not decrease the losses of ascorbic acid. The best results, i.e., smallest changes, were obtained when juices were irradiated in the frozen state at 77°K. (auth)

21991 USE OF RADIATION IN THE PRESERVATION OF THE SPANISH ORANGE. Saiz de Bustamante, C.; Garcia de Mateos, A.; Hernandez Gimenez, E.; Safont Tomas, A. (Junta de Energia Nuclear, Madrid. Instituto de Agroquimica y Tecnologia de Alimentos, Valencia). Rev. Agroquim. Tecnol. Aliment.; 10: 371-82(Sep 1970). (In Spanish).

The fungicidal capability of γ radiation on the fungi of oranges was appraised in relation to the successful effects of (2-biphenyl-yloxy) sodium. The tests were conducted with Penicillium italicum, Alternaria citri, and Rhizopus nigricans, studying the influence of the type of infection and the postirradiation temperature on their radiosensitivity. The variety of oranges used was Valencia Late, and the doses used were between 50 and 300 K rad. The results indicated that when the oranges were inoculated exclusively with the spores of Penicillium, doses between 100 and 200 K rad were sufficient to inhibit the development of the fungus. Lower doses retarded germination of the spores. However, in the case of Alternaria, doses in excess of 300 K rad were required to stop development completely. The variety of orange used in the test was found to be sensitive to irradiation to the extent that it induced tissue necrosis in the oil secreting glands, dark spots appearing over the surface of the fruit. Waxing and refrigeration deminished the undesirable effect. (tr-auth)

21992 RADIOSTERILIZATION. Icre, P. (Societe de Recherches Techniques et Industrielles, Orsay, France). Tech. Mod.; 62: 438-40(Oct 1970). (In French).

The development of radiosterilization (choice of irradiation dose and sources) is studied. The techniques and operations used in a center specializing in the radiosterilization of medical and surgical equipment are described. (France)

21993 RADIOSTERILIZATION OF FOODS. Oka, Mitsuru (Tokyo Metropolitan Isotope Research Center). Shokuhin Eiseigaku Zasshi; 11: 229-37(Aug 1970). (In Japanese).

The study of food irradiation has been carried on for the purpose of sterilizing and insecticides and controlling germination. The

most difficult point of the study lies in the compromise between its effect and the degradation of food. As the real radiosterilization for food, three methods are applied depending on the purposes: radappertization, radurization and radicidation. The radapperatization is a method of obtaining commercial sterility. The standard coefficient for this method is 12D, and 4.5M rad. is applied for perfect sterilization. It is calculated as follows: 12 times of 0.33M rad required for killing Cl. botulinum, the most resistant bacterium, plus safety factor of 10%. The radurization is applied for the purpose of prolonging preserving period and reducing the number of bacteria. Comparatively low dose irradiation is effective to kill saprogenic bacteria and to change micro florae in food to prolong the preservation period. When heat treatment is applied together with irradiation, the effect can be more noticeable. The radicidation is applied for complete sterilization which brings some problem from the view point of food sanitation. The dose effective for killing Cl. botulinum and Salmonella sp. is 0.5 to 1.0M rad, and vibrio parahaemolyticus is also to be killed with the same dose level as radurization. The cost required for the radappertization is 100 yen/kg, and for the radurization it is 10 yen/kg. The problem for the future study will be how to put them to practical use and to reduce the cost. (Japan)

21994 CIRCULIFER TENELLUS BAKER (HOMOPTERA: CICADELLIDAE). CONTROL OF REPRODUCTION BY STERILIZATION PROCEDURES. Ameresekere, Rajasingha Victor Wyndham Ekanaike. Riverside, Calif.; Univ. of California (1969). 191p. University Microfilms Order No. 70-19,221.

Thesis.

The feasibility of employing a sterilization procedure for the control of reproduction in the beet leafhopper, Circulifer tenellus Baker (Homoptera: Cicadellidae) as an alternative to control by insecticides was investigated with chemosterilants and ^{60}Co γ irradiation. The standard toxicological techniques used for chemosterilization of insects were evaluated on the beet leafhopper. Topical application was not possible due to solvent toxicity. Contact exposure to the Olin Mathieson chemicals OM 53139, Om 53362, and OM 53264, at a dosage of 1% induced moderate sterility. Oral administration proved to be an efficient means of sterilization. N' N, hexamethylene bis-1-aziridine carboxamide (OM 53139) an alkylating agent was selected as a model oral sterilant because it was of relatively low toxicity to the insect and induced high sterility. Sterility tests over a 30 day period suggested a permanency of effects in the females, whereas a slight recovery occurred in some males. Cobalt-60 γ irradiation as an alternative to chemical sterilization was tested on nymphs and adults. Males were less susceptible than females at the LD_{95} level. The minimum effective dosage required to sterilize 95% to 100% of males (17.5 kr) was about 4.2 times greater than that needed for females (4.1 kr). Nymphs were more susceptible than adults to sterilization by γ irradiation as well as by chemosterilants. Histopathological examinations of irradiated males and females indicated nuclear degeneration, and atrophy and also spermatogonial and oogonial death. Sterility results also suggest that sperm inactivation does occur in both irradiated and OM 53139-treated males. Chemosterilized females showed more drastic pathological changes than the irradiated females. Abnormalities observed in hermaphrodites which had been treated with OM 53139, may be due to the bisexual condition rather than to the sterilant. Certain biotic effects of sterilization such as longevity and mating competition were also evaluated. The longevity of males was severely reduced by exposure to the minimum effective irradiation dosage; but was not affected by the chemosterilant treatment. In contrast, the effective dosages of irradiation and chemosterilants had no effect on the longevity of treated females. OM 53139-treated males were equally competitive as normal males, under laboratory conditions. These findings indicate that a sterilization procedure for the beet leafhopper may be further explored with a view to employing it in an integrated program of control. (Diss. Abstr. Int., B)

21995 RADIATION-INDUCED SARCOPLASMIC PROTEIN FRACTION IN MEAT IRRADIATED AT 0 AND -30° C. Radola, B. J. Kaeltetech.-Klim.; 21: 323-6(1969). (In German).

Sarcoplasmic proteins from beef and pork were separated by means of thin-layer gel filtration on Sephadex G-75, G-100 and G-200. When the G-200 gel was used, five fractions with RM values of 1.0 to 2.15 were regularly detected on both kinds of meat. When meat was irradiated in the dose-range of 1 to 5 Mrad a new fraction with a RM value of 2.35 to 2.45 was observed. The size of this radioinduced fraction depended upon the dose and temperature during the irradiation process. The samples irradiated with 5 Mrad contained more of the radioinduced fraction than the 1 Mrad samples, and this fraction was smaller after irradiation at −30°C than after irradiation at 0°C. Sarcoplasmic proteins from meat samples subjected without irradiation solely to several freezing and thawing-out cycles at −30°C and 20°C showed only traces of a fraction with a RM value of 2.4. The radioinduced fraction probably consists of aggregates of sarcoplasmic proteins. Aggregate formation was detected during the irradiation of the isolated sarcoplasmic proteins. (auth)

21996 TRENDS IN THE UTILIZATION OF RADIATIONS AND RADIOSIOTOPES. FOOD IRRADIATIONS. Matsuyama, Akira (Inst. of Physical and Chemical Research, Yamato, Japan). Genshiryoku Kogyo; 16: No. 4, 110-12(Apr 1970). (In Japanese).

The main purpose of the irradiation of food is to improve the storage life of food. Sterilization is applied for two cases; one is to prolong preservation period by the low dose irradiation of less than 1 Mrad, and the other is to obtain complete sterilization by the high dose irradiation of 1 to 5 Mrad. Another feature of the irradiation is negligible temperature rise, and all the food can be sterilized, insect-killed, and prevented from germination in fresh condition, except some special cases. Food irradiation has been studied and developed in the U.S., Canada, West Germany, and the Soviet Union, while in Japan it has been developed on the basis of studying and developing food irradiation by the Atomic Energy Commission. Items to be investigated include the use of γ radiation for the sterilization of pastes of marine products, irradiation for preventing the germination of potatoes and onions, and killing of insects infesting rice, wheat and microorganisms causing spoilage of oranges. Investigations concerning meat and fishery products are also scheduled in the future. The data on the safety of food irradiation have been accumulated, and some concrete ideas on the approval of radiation processed food for human consumption, the legal problem concerning food irradiation, and the construction of a food irradiation center are discussed. (Japan)

21997 EFFECT OF THE STORAGE TEMPERATURE OF IRRADIATED SEEDS ON FREQUENCY OF CHROMOSOME ABERRATIONS. Pomogaibo, V. M. Tsitol. Genet.; 4: 275-7(1970). (In Russian),

A preserving effect was found for lowered temperature (-3°C) on the development of radiation damages during long storage of irradiated winter rye seed. The data obtained are in agreement with the results of analogous experiments with irradiated animals. These data suggest that in the irradiated biological systems during the state of hypothermal dormancy the formation of metabolites and growth of their concentration stop, which is a variable component of biological effects of radiation during the storage of irradiated biological material. (auth)

21998 EFFECT OF IONIZING RADIATION ON FOOD PRODUCTS. Bychkov, V. P.; Kozar, M. I.; Popov, N. N.; (and others). Kosm. Biol. Med.; 4: No. 5, 42-6(Sep-Oct 1970). (In Russian).

Studies were made on the effects of γ irradiation with doses of 35,000 and 70,000 rads on physicochemical and organoleptic properties of casein, sunflower seed-oil, yeast, and oil concentrates of vitamins A and D. It was found that a single irradiation of the products with the above doses reduced some essential amino acids, destroyed significant amounts of water-soluble and small quantities of fat-soluble vitamins in the foods, and increased the concentration of peroxides in sunflower oil. (auth)

21999 PHYSIOLOGICAL STUDIES OF GAMMA-IRRADIATED TOMATO FRUITS. II. EFFECTS ON DETERIORATION AND SHELF LIFE. Abdel-Kader, Adel S.; Morris, L. L.; Maxie, E. C. (Univ. of California, Davis). Proc. Amer. Soc. Hort. Sci.; 93: 831-42(1968).

Tomato fruits of the cultivars "Early Pak No.7" and "Ace" were harvested at various stages of ripeness, irradiated in a cobalt-60 gamma source at doses between 100 and 700 kilorad (Krad), and held at various temperatures. Irradiation damage was less in fruits irradiated at the pink or table-ripe stage than in fruits treated at the mature-green or breaker stage. Shelf life was not extended with mature-green or breaker fruits, but was extended 4 to 12 days with pink or riper fruits given doses between 250 and 350 Krad. (auth)

22000 PHYSIOLOGICAL STUDIES OF GAMMA-IRRADIATED TOMATO FRUITS. III. EFFECTS ON ASCORBIC ACID CONTENT, ACIDITY, AND TEXTURE. Abdel-Kader, Adel S.; Morris, Leonard L.; Maxie, E. C. (Univ. of California, Davis). Proc. Amer. Soc. Hort. Sci.; 93: 843-53(1968).

Gamma irradiation of tomato fruits reduces their ascorbic acid content, in greater proportion in pink and table ripe than in mature green fruits. Final total ascorbic acid, however, is higher in irradiated pink and table ripe fruits than in subsequently ripened irradiated mature green fruit, because of a higher initial concentration of the vitamin. Irradiated tomatoes had a lower

total acidity and higher pH than unirradiated fruit. Soluble solids content was not affected by irradiation, whereas firmness was reduced markedly. (auth)

22001 EFFECTS OF GAMMA IRRADIATION ON CHANGES IN ACIDITY, VITAMIN C, AND NON-PROTEIN NITROGEN OF APPLES. Saito, Zenichi; Igarashi, Yasuo (Hirosaki Univ., Aomori, Japan). Hirosaki Daigaku Nogakubu Gakujutsu Hokoku; No. 16, 1-9(Mar 1970).

Jonathan apples were irradiated with ^{60}Co γ rays at doses of 0 to 1500 Krad, and stored at 0°C for 0 to 4.5 months (some for 6 months). The content of reduced-type vitamin C decreased by γ irradiation with 1000 Krad to less than one tenth of the control lot. Slight or no effect was observed in pH, total vitamin C, and non-protein nitrogen. The effects of γ radiation became significant, except in the case of non-protein nitrogen, after cold storage. Acidity decreased with irradiation of 300 to 750 Krad. Apparent total vitamin C of irradiated apples (1000 and 1500 Krad) increased in relation to the storage period to about $\frac{1}{3}$ the quantity of vitamin C in apples that were not stored. (auth) (Japan)

22002 COMPARISON OF THE QUALIFICATIONS OF HEAT- AND RADIATION STERILIZATION OF PRESTARTER FOODS FOR THE ADAPTATION OF GNOTOBIOTIC PIGLETS TO THE SPECIFIC PATHOGEN-FREE STATUS. Sickel, E.; Diehl, J. F.; Gruenewald, Th. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Tierphysiol. Tierernaehr. Futtermittelk.; 25: 258-69(1969). (In German).

During gradual adaption to the SPF-status 95 gnotobiotic, 14-day-old piglets were fed a prestarter diet that was sterilized either by fractionated heating (2 × 90 min at 80°C) or by electron irradiation (3.5 Mrad). Half of the piglets had received a stress diet low in mineral trace elements during the first 14 days of life. Results with the irradiated diet were somewhat better than those with the heat sterilized diet, as evidenced by lower losses and fewer banal diseases. As compared to the heated diet, most of the essential amino acids, particularly lysine, were present in slightly higher amounts in the irradiated diet. The relative viscosity of a diet slurry was independent of the sterilization process, provided an equal water content was present in each slurry preparation. Protein digestibility in vitro was also unaffected by the method of sterilization. Another 141 gnotobiotic piglets were fed a commercial pelleted diet from the 15th day of life without any prestarter diet. Judged by the number of piglets lost and by the number of required medications, this was less advantageous than the use of the radiation-sterilized prestarter diet during the 3rd week of life. (auth)

22003 STUDIES ON THE BROWNING OF POTATO TUBERS BY GAMMA RADIATION. 1. HISTOLOGICAL OBSERVATION AND THE EFFECTS OF THE TIME OF IRRADIATION AFTER HARVEST, LOW TEMPERATURE, AND POLYETHYLENE PACKAGING. Ogata, Kuniyasu; Tatsumi, Yasuo; Chachin, Kazuo (Osaka Prefectural Univ., Sakai, Japan). Nippon Shokuhin Kogyo Gakkaishi; 17: 298-302(Jun 1970). (In Japanese).

The relations between the browning of potato tubers caused by gamma radiation and the time of irradiation after harvest or maturity of the tubers at harvest were referred. The effects of polyethylene package and low temperature on the browning were also discussed. Potato tubers were irradiated with the doses of 5 to 40 Krad and stored at room temperature. The browning induced by radiation was partially observed around the vascular bundle of the tubers and the death of the cells was noted. It was enhanced from 3 to 7 days after irradiation. The partial browning occurred in the tubers irradiated with the doses of 10 to 40 Krad one month after harvest. However, when the tubers were irradiated 2 months after harvest, little browning was observed with doses of 10 and 20 Krad, but at 40 Krad browning still occurred. The browning may be enhanced more in immature tubers (small tubers) than in mature ones (large ones). The polyethylene packing during irradiation and the following several days may reduce the browning. The treatment of low temperature (5 to 7°C) after irradiation may also suppress the development of the browning. (Japan)

22004 STUDIES ON THE FLAVOR OF γ-IRRADIATED AND COOKED RICE. Nakamura, Hideko (Hokkaido Univ. of Education, Iwamizawa, Japan); Obata, Yataro. Hokkaido Kyoiku Daigaku Kiyo, Dai-2-Bu, C; 20: No. 2, 39-44(Jan 1970). (In Japanese).

Irradiated rice at dosages of 5, 10, and 20 Krad of γ-rays was cooked in cans, and its chief space vapors were examined by GLC. Many liquid by phases were tested for good separations and were assorted into 5% PPG, 20% DOP, and 20% LAC. Aromagrams were obtained from freshly irradiated and cooked rice (5, 10, and 20 Krad) by GLC, and the aromagrams of rice irradiated at 5 and 10 Krad did not differ significantly from those of unirradiated rice, while a difference was found between the aromagram of 20 Krad-irradiated rice and that of the others. After being stored for 3 months at room temperature there was no remarkable difference between them. (Japan)

XUM

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 21258 and 21263.

22005 FIZIKA METALLICHESKIKH PLENOK. (Metal Coating Physics). Svechnikov, V. N. (ed.). Respublikanskii Mezhvedomstvennyi Sbornik, Metallofizika 26. Kiev; Naukova Dumka (1969). 116p.

Information concerning metal coatings is presented in sixteen chapters. A separate abstract was prepared for each of four chapters. Chapters for which no abstracts were prepared are not within scope of NSA. (J.R.D.)

22006 PHYSICAL AND FABRICATION METALLURGY. Proceedings of the Ninth Commonwealth Mining and Metallurgical Congress, London, May 3–24, 1969. Volume 4. Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970). 561p. £ 8. (CONF-690561–(Vol. 4)).

Twenty-four papers were presented in this section of the congress of which three were considered in scope for NSA. Individual abstracts were prepared for these three papers. (UK)

For abstracts of individual papers see: 21258, 22123, and 22207.

22007 SECOND EUROPEAN CONFERENCE ON THERMOPHYSICAL PROPERTIES OF SOLIDS AT HIGH TEMPERATURES, SALFORD, ENGLAND, APRIL 7–10, 1970. Rev. Int. Hautes Temp. Refract.; 7: 180-306(Jul-Sep 1970). (In French). (CONF-700431).

Eighteen papers were presented in the first part of the conference. A separate abstract was prepared for each of 9. The remaining papers were not within scope of NSA. (France)

For abstracts of individual papers see: 22088–22091, 22175–22178, and 22198.

22008 LAWS OF MATERIAL DEPOSITIONS ON HEAT-TRANSFER SURFACES DUE TO THERMOELECTRIC EFFECTS. Brusakov, V. P. At. Energ. (USSR); 30: 10-14(Jan 1971). (In Russian).

The role of thermoelectric effects in the process of deposit formation on heat transfer surfaces is discussed. Equations are derived to calculate the precipitation rate for suspended charged particles and the electrochemical deposition of elements. The factors influencing these rates are concentration, thermal flow, charged particle mobility, and the presence of additives, and others. (auth)

Corrosion and Erosion

Refer also to abstract 23118.

22009 (CEA-CONF-1728) DRY CORROSION AND PROTECTION OF Zr AND ITS ALLOYS. Darras, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 49p. (In French). (CONF-701040–1). Dep. NTIS (U. S. Sales Only).

From Meeting on Corrosion, Toulouse, France.

Long term exposure of Zr to CO_2 at temperatures above 500°C results in destructive oxidation. Two features are associated with oxidation: the development of a superficial layer of oxide, which is very sensitive to fissuration, and the dissolution of oxygen into the bulk of the metal which makes it fragile. Zr-Cu alloys containing between 1.6 and 3% Cu (by weight) were studied. The corresponding oxidation kinetics are parabolic until a temperature of at least 650°C is reached, the optimum composition being about 2.5%. The addition of Cu limits significantly the absorption of hydrogen in the presence of low water vapor concentrations. The increased fragility due to the dissolution of oxygen in Zr can be avoided by using very thin protective metallic coatings. The superiority of Zr-Cu alloys is discussed. (France)

22010 (DP-Report–532) CORROSION OF MILD STEEL CIRCUITS IN 1.5 PERCENT LITHIUM SULPHATE SOLUTION, UNDER HEAT TRANSFER CONDITIONS. Project DRAGON. Gray, P. S.; Gilling, G.; Thorneycroft, A. B. (Atomic Energy Establishment, Winfrith (England)). Mar 1967. 42p. Dep. NTIS (U. S. Sales Only).

The Dragon Reactor Secondary Circuits were to be operated with a solution of a neutron poison in place of the normal boiler water. After investigation of possible solutions and preliminary corrosion experiments, a forced circulation test rig was constructed with heat transfer and steaming conditions near to those of the secondary circuits. It was found that corrosion of secondary circuit mild steel by 1.5% lithium sulfate solution appeared acceptable up to at least a year of operation, providing heat transfer conditions were fairly uniform. The effect of 1.7% potassium borate solution is also described. (auth)

22011 (KFK–1251) EXPERIMENTAL INVESTIGATION OF THE WEAR CHARACTERISTICS OF STEEL AND ALLOYS IN LIQUID SODIUM. Wild, E.; Mack, K.; Hoffmann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Aug 1970. 46p. (In German). Dep. NTIS (U. S. Sales Only).

The wear due to operation of bearings, guides, supports, and holders of components of sodium-cooled reactors can be limited to a large extent or reduced to a minimum by the choice of suitable material combinations. This requires knowledge of the sliding and wear behavior of a maximum number of material combinations which can be set up from structural materials, hard facing alloys and hard metals and whose compatibility with the operating medium has been proved. The type of wear investigations deemed to be useful in view of the problem points the related questions of materials and the experimental facility used are described. (auth)

22012 (ORNL–4575(Vol.1)) CORROSION IN POLYTHERMAL LOOP SYSTEMS. I. MASS TRANSFER LIMITED BY SURFACE AND INTERFACE RESISTANCES AS COMPARED WITH SODIUM–INCONEL BEHAVIOR. Evans III, R. B.; Nelson, Paul Jr. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 42p. Dep. NTIS.

Corrosion studies of Inconel and similar nickel-base alloys in flowing sodium have shown that considerable quantities of nickel are removed from regions hotter than 1300°F and deposited in cooler regions. The observed nickel mass transfer rates with predictions based on the assumption that diffusion of nickel across the liquid boundary layer at the alloy surface controls the process were compared. For pumped loops operating in the turbulent flow regime, it was demonstrated analytically that the time transient required to achieve steady-state mass-transfer conditions is relatively short compared with normal loop operating times. Based on a calculated film coefficient, the predicted transport of nickel from the hot zone was five times greater than that obtained from measurements of crystal deposits in cold zones. This and other considerations suggest that contributions of film resistances are only partially responsible for corrosion in polythermal loops containing liquid metals. In other words, a complete description of the corrosion process will require considerable modification of the mechanism discussed here. All results were derived from a simple partial differential equation which is first order with respect to time and position. The solution of the differential equation is found in closed form; accordingly, it can be readily manipulated to exhibit the transient and steady-state parts. The solution will accommodate a wide variety of assumed experimental conditions. It holds for heat- as well as mass-transfer problems. (auth)

22013 (ORNL-tr–2448) EFFECT OF OTHER GASES ON THE BEHAVIOR OF GASEOUS HYDROGEN AND ITS ISOTOPES WITH RESPECTS TO METALS. Fidelle, J.; Broudeur, R.; Clauss, A. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from pp 324-54 of Conference on Hydrogen in Metals, Valduc, France, September 27–28, 1967. 41p. (CONF-670993–1). Dep. NTIS.

The permeation of a metal by hydrogen gas and its isotopes takes place in successive stages including adsorption, absorption, diffusion, deabsorption, deadsorption, one or more of these being also involved in embrittlement processes. The action of foreign gases (GE) can affect that of hydrogen during one of these stages, in one of three media. It is found that foreign gases other than hydrogen may have no effect or may induce, increase, or reduce its action. When the foreign gas is an isotope of hydrogen there is always interference between the isotopes and at the inlet interface, GE plays an active part and the two isotopes compete. In metal, two situations arise according to whether GE and GP (principal gas) are different or identical. In the former case GE has a passive damping action, and must be partially displaced by GP before this latter can permeate normally. On the contrary, in the latter case the permanent permeation conditions are generally reached more quickly. If GE is present in the outgoing gas phase there is competition once more between GE and GP, permeation of GP decreases while embrittlement, due to the isotopes, increases. (auth)

22014 (RT/ING-(70)14) PARAMETRIC EXPERIMENTAL INQUIRY ON "FRETTING CORROSION" IN METALS. Lupoli, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1 Jul 1970. 36p. (In Italian). Dep. NTIS (U. S. Sales Only).

An experimental study on fretting corrosion of stainless steel–copper and stainless steel-Zircaloy-2 pairs in water at ambient temperature was carried out. During test the contact pressure was varied between 50 and 250 kg/cm^2 and the frequency of relative motion between 0.6 and 130 cps. The results obtained are analyzed and discussed. (auth)

22015 (WARD-4210-T-1-1) CARBON EQUILIBRIUM LOOP CONTINUATION. Sodium Technology Program Progress Report for the Period Ending November 30, 1970. Ray, William E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jan 1971. Contract AT(30-1)-4210. 51p. Dep. NTIS.

Research results are reported for a program directed toward determining the rates and direction of C and N transfer in structural materials used with high-temperature sodium. Information and data are included on design, construction, and operation of carbon equilibrium loops, electrochemical carbon meter design and operation, cover gas analysis, determination of oxygen in sodium, and models of mass transfer in sodium. (J.R.D.)

22016 USE OF RADIOISOTOPES AND RADIATION FOR THE STUDY OF CORROSION PREVENTION. Morozumi, Takashi (Hokkaido Univ., Sapporo). Boshoku Gijutsu; 19: 224-31(Jun 1970). (In Japanese).

The use of radioisotopes and radiation for the study and testing of corrosion protection is reviewed. Information is included on the use of radioisotopes as a tracer for determination of the leaching rate and corrosion rate of samples, adsorption rate on the surface of samples, and the surface properties of samples. Information is also included on autoradiography, radiography, use of radioisotopes as markers, use of the backscattering phenomenon of radiation, analysis of metal surface layers by the application of nuclear reactions, structural analysis of the products formed by corrosion using Moessbauer effect, and activation analysis. (Japan)

22017 STRESS-WAVE EMISSION AND FRACTURE IN 6Al–4V TITANIUM. Green, Allen T. (Dunegan Research Corp., Livermore, Calif.). Metals Eng. Quart.; 11: No. 1, 61-2(Feb 1971).

Stress-wave emissions detected from subcritical crack growth in thin walled (0.030 and 0.060 in.) 6Al-4V titanium were successfully achieved and demonstrated in air, inhibited water, and methyl alcohol environments. The stress-wave emission characteristics which were determined as precursors of failure were the same for all environments investigated; these are: the rate-of-occurrence, the total cumulative count, and the amplitude of stress-wave emissions, all of which increased significantly as failure approached. (auth)

22018 INHIBITION OF METHANOL CRACKING OF Ti–6Al–4V FOIL: EFFECT OF PRETREATMENTS WITH AQUEOUS SOLUTIONS OF ELECTROLYTES. Haney, E. G.; Fugassi, Paul (Carnegie-Mellon Univ., Pittsburgh). Corrosion; 27: 46-8 (Jan 1971).

Pretreatment of Ti-6Al-4V foil with aqueous solutions of chlorides for one hour can greatly inhibit the initiation of stress corrosion cracking of the foil in methanol containing 0.2% by volume of water and 0.01M in NaCl. The cations of six different elements were particularly effective, and half of these six elements occupy adjacent positions in the fifth period of the periodic table. With hydrogen ions as the common cation, the most effective anion was nitrate. Dilute equivolume mixtures of nitric and hydrochloric acid were very effective inhibitors of stress corrosion cracking. The experimental results are explained on the assumption that the surface oxide layer of untreated alloy contains microcrystallites of colloidal dimensions, which in the stress corrosion test are the locus for the attack of the base metal by methanol. The effect of the pretreatment is to destroy in some manner the colloidal character of the microcrystallites and to make a surface film more resistant to methanol attack. (auth)

22019 PLANE OF CRACK PROPAGATION IN STRESS CORROSION FRACTURE IN COPPER BERYLLIUM. Sylwestrowicz, W. D. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Corrosion; 26: 552-9(Dec 1970).

Single crystals of a copper-beryllium alloy of two axial orientations ([111] and [110]) strained in tension showed slip on {111} planes. The same crystals, stressed in tension and exposed to an ammonia atmosphere, failed in a transcrystalline mode. In crystals of [111] orientation cracks propagated on (123) planes. Calculations show that in these crystals, the maximum resolved shear stress on the ($\bar{1}$11) slip planes was produced when the crack propagated on the (123) plane. In crystals of the [110] axial orientation, the cracks propagated on (110) planes. Again calculations showed that the maximum resolved shear stress on the (111) slip planes was produced when the crack propagated on the (110) plane. These results indicated that crack propagation occurred on planes which would result in the maximum plastic deformation on the available slip system. (auth)

22020 NEW ACCELERATED CORROSION TEST. SALT SPRAY AND AIR POLLUTION. Goethner, Guy A. Metal Finish.; 68: No. 5, 45-7; 55(May 1970).

A new accelerated salt spray and air pollution test that used actual sea water and simulated thermal and humidity effects found in open and partially protected areas was developed for evaluating deposits of Cr, Sn, Ni, and Cd on brass and steel substrates. The test detected corrosion due to either attack of the basic material through thin or very porous plating areas or to attack of the plating surface by differential aeration cells and the formation of corrosive salts combined with atmospheric dust. (Metals Abstr.)

22021 PITTING CORROSION IN NICKEL SINGLE-CRYSTAL ELECTRODES OF DIFFERING PURITY. Garz, I.; Worch, H. Wiss. Z. Tech. Hochsch. Otto von Guericke Madgeburg; 14: No. 1, 77-9(1970). (In German).

Experimental work on Ni single-crystal electrodes whose (111) plane formed the electrode surface in 0.5M $NiCl_2$ solution is reported. Purity varied from 99.44 to 99.93% and details of impurities are given. Current density/potential curves and diagrams showing the types of pitting produced under various conditions are given and the results discussed. (Metals Abstr.)

22022 HIGH TEMPERATURE OXIDATION PROPERTIES OF Nb–Al AND Nb–Be ALLOYS IN THE TEMPERATURE RANGE 485° TO 1035°C. Yamawaki, Michio; Kanno, Masayoshi; Mukaibo, Takashi (Tokyo Univ.). Denki Kagaku; 38: 886-93 (Dec 1970).

The thermal oxidation properties of Nb-1.0 to 4.0 at.% Al alloys, Nb-0.8 to 9.8 at.% Be alloys as well as pure niobium were investigated by means of thermogravimetric measurements, x-ray diffraction, and metallographic methods. The tests were conducted at temperatures ranging from 485 to 1035°C in dry oxygen at a pressure of 0.2 atm. Five modifications of the dominant product Nb_2O_5 i.e., δ, $\delta-\gamma$, γ, α', and α were identified and the transition temperature of the structure of each modification gradually increased with increasing Al content in Nb–Al alloys, even though it was scarcely influenced by increasing Be content in Nb–Be alloys. Transitions from parabolic to linear kinetics were observed to occur in scaling of each specimen at lower temperatures. The linear oxidation rates of Nb–Al alloys were lower than the ones of niobium below 585°C, but above 635°C the former became higher. The linear rates of Nb–Be alloys were higher than the ones of niobium at all temperatures investigated. Such behaviors were explained in connection with the change in a tendency of the scale to cracking caused by alloying. On the other hand the parabolic rate constants calculated were hardly affected by alloying niobium with Al as well as Be. (auth) (Japan)

22023 CORROSION OF ELECTRODEPOSITED ZINC AND CADMIUM. I. RATES IN NATURAL ATMOSPHERES. Biestek, Tadeusz. Metal Finish.; 68: 48-53(Apr 1970).

The corrosion resistance of electrodeposited Zn and Cd coatings on steel was tested for an 11-year period in industrial, urban, urban–industrial, marine, rural, and tropical atmospheres. The Zn coatings were deposited from both cyanide and sulfate baths. Results were used to obtain the average corrosion during a year and thus predict service life in these atmospheres for a coating of known thickness. In all cases, calculated corrosion rates lay within the ranges determined in other countries. Zinc coatings from a cyanide bath had about twice the service life of Cd coatings of the same thickness and about 1.5 times that of Zn coatings from a sulfate bath. The different behavior of the two types of Zn coatings was probably caused by differences in crystal structure and deposit grain size. (Metals Abstr.)

22024 PROGRESS IN THE DEVLOPMENT OF HOT CORROSION RESISTANT ALLOYS FOR MARINE APPLICATION. Sims, Chester T.; Bergman, Paul A.; Beltran, Adrian M. Nav. Eng. J.; 82: No. 2, 39-47; 50-1(Apr 1970).

Several Ni- and Co-based superalloys were evaluated for hot corrosion resistance, rupture strength, and ductility to determine their suitability for use as buckets and partitions in marine gas turbines operating at firing temperatures to 1750°F. Among the Ni alloys, Melni-6, 19, and 22, U-500 + Ce and U-700 + Ce were considerably more resistant to corrosion, especially at 1750 to

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1800°F than U-500. Chromium had the most beneficial effect on resistance to typical sulfidication-type hot corrosion and was capable of counteracting the effects of elements such as Mo. Aluminum was most important for oxidation resistance above 1800°F; rare-earth additions of Ce and La were beneficial, and Ta, W, Co, and Re had relatively mild effects. The Ni–Melni alloys, however, did not have the required rupture strength. The Co-base alloys Melco-2, 9, and 10 were the most corrosion resistant up to 2050°F; additions of Y increased their resistance, while Ni and Ta reduced it slightly. The Co–Melco alloys met, and in some instances, exceeded required rupture strengths. In alloys of poor or intermediate hot corrosion resistance, attack can increase with temperature to a max (the hot corrosion terminal temperature), which is followed by a sharp reduction in attack until the alloy begins to suffer more classic oxidation reactions. (Metals Abstr.)

Preparation and Fabrication

Refer also to abstracts 21144, 21304, 22140, 22353, and 22919.

22025 (IN–1422) STUDY OF THE FLUDIZED-BED PROCESS FOR PRODUCTION OF URANIUM ALUMINIDE. Hogg, G. W.; Grimmett, E. S. (Idaho Nuclear Corp., Idaho Falls). Nov 1970. Contract AT(10-1)-1230. 29p. Dep. NTIS.

The four-step fluidized-bed process for producing uranium aluminide nuclear fuel particles was studied using a two-inch-diameter fluidized-bed pilot plant. Experimentally confirmed reaction rate correlations based on mathematical models were developed. Conditions necessary for obtaining highly reactive fluidized particles were investigated. The experimental data indicated that the fluidized-bed process for producing uranium aluminide was feasible if an effective product water wash was employed to remove excessive chlorides and aluminum oxide. Those areas of development requiring additional attention before the process is ready for use on a plant scale are outlined. (auth)

22026 (IS-T-408) PART I. PREPARATION OF LANTHANIDE SINGLE CRYSTALS. PART II. ELASTIC MODULI AND THERMAL EXPANSION OF LUTETIUM SINGLE CRYSTALS FROM 4.2 TO 300°K. Tonnies, James John (Ames Lab., Iowa). Feb 1971. Contract W-7405-eng-82. 79p. Dep. NTIS.

Thesis.

I. A study was made on three methods that could be used in preparing large single crystals, approximately 1.25 cm (0.500 inch) in diameter and in length, of the light lanthanide metals, praseodymium and neodymium, and the heavy lanthanide metal, lutetium. The strain–anneal process with its variations was successfully applied in preparing lutetium crystals. The electron-beam-floating-zone technique and the crystallographic transformation method showed the greatest promise for praseodymium and neodymium. II. The adiabatic elastic moduli and linear thermal expansion coefficients of lutetium single crystals were calculated from 4.2 to 300°K, from sound-wave transit times and density values. The ultrasonic pulse superposition technique was employed to determine transit times, and a linear-variable-differential-transformer dilatometer to determine densities. The Debye characteristic temperature and the bulk elastic properties (Young's modulus, Poisson's ratio, the shear modulus, and the bulk modulus) were calculated from the elastic moduli. (auth)

22027 HIGH-STRENGTH, LOW-TEMPERATURE BONDING OF BERYLLIUM AND OTHER METALS. Knowles, James LeRoy. Berkeley, Calif.; Univ. of California (1970). 123p. University Microfilms Order No. 71-741.

Thesis.

An investigation was conducted to determine the feasibility of techniques for bonding beryllium as well as other metals at low temperatures and to establish the relationship of the bond parameters to the bond strength. This study was guided by the following conditions: bonding temperature should be less than 600°F; plastic deformation of the parent metal should be minimized; and the bond should be nearly as strong as the parent metal. The final condition was intended to apply to type S 200 beryllium. Additional tests were made on molybdenum, stainless steel, tungsten, and commercially pure copper. It was early established that bonds could not be accomplished within the required temperature range and with small parent metal distortion without the use of an intermediate material. Consequently, all the results reported herein are for specimens with a plated dissimilar metal, generally silver, on the surfaces being joined. A special cleaning treatment was required after this second material was applied. Bonding atmospheres varying from a vacuum of 2×10^{-6} torr to helium, oxygen, and air have no significant influence on bond strength. For a fixed applied bonding compressive stress, bond strength increased when the modulus of elasticity of the substrate was increased. The thickness of the intermediate material was also significant in determining bond strength for the same processing conditions. When the plating thickness was varied from 35 to 200 μin., the bond strength was approximately doubled. The presence of the plated material and the subsequent preparation of the surface resulted in a very small notch in the surface of the specimen at the bond interface. When this imperfection was removed after bonding, the bond strength was again almost doubled. Data from beryllium tests showed that a partial bond was formed at a temperature of slightly less than 225°F. At 280°F, bond strengths in beryllium could be obtained approaching that of the bulk material with a plating thickness of approximately 200 μin. Also, bond strength increased linearly with increased applied bonding compressive stress. This result fits the adhesion model of bonding. It may be concluded from this study that bonds that exhibit beryllium fracture strength (40 ksi) and that were especially prepared after plating can be made at 225°F on plated beryllium. Experimental data indicate that an adhesion or cohesion model is the bonding mechanism. This conclusion is based on the linear relationship of the bond strength to bonding compressive stress and the independence of bonding time. Bond strengths were very dependent upon the thickness of the plating; the strengths increased with increasing thickness up to 600 μin. (Diss. Abstr. Int., B)

22028 MANUFACTURING PROCESS FOR U-700 ALLOY THIN GAGE SHEET. Kelley, E. W. (Cabot Corp., Kokomo, Ind.). Metals Eng. Quart.; 11: No. 1, 10-16(Feb 1971).

Thin gage U-700 sheet with superior properties could be manufactured on a production basis. The limited temperature range of useful hot workability of cast U-700 was significantly extended by electroslag remelting. The limited hot ductility of cast U-700 was effectively improved by a homogenization heat treatment at 2050°F for 4 hr. The optimum temperature range for hot working cast U-700 was 2050 to 1850°F. Intermediate annealing of cold worked U-700 to soften it for further deformation processing was accomplished by an overaging heat treatment at 1950 to 1975°F followed by a water spray quench. Boron loss from U-700 sheet of thicknesses less than about 0.060-in. was critical at high temperatures in an oxidizing atmosphere. During high-temperature exposure of thin gage U-700 sheet, oxidation protection was therefore important to the retention of boron, which in turn is vital to the high temperature properties of the alloy. (auth)

22029 ELECTRON-BEAM WELDING OF MOLYDENUM. McGregor, W. P.; Marquez, H. Weld. Design Fabr.; 43: No. 4, 82-4(Apr 1970).

Molybdenum electrical heating elements for a closed-cycle gas loop of an advanced test reactor were fabricated by electron beam welding. The production process included careful cleaning and desmutting, assembly of the tubes, fittings and 19 ceramic insulators, welding and complete visual, ultrasonic, and metallographic testing. (Metals Abstr.)

22030 TRANSACTIONS OF THE AMERICAN FOUNDRYMEN'S SOCIETY. VOLUME 77. Proceedings of the Seventy-Third Annual Meeting, Cincinnati, May 5–9, 1969. Des Plaines, Ill.; American Foundrymen's Society (1969). 507p. (CONF-690560).

Approximately 64 papers were presented at the conference. An abstract was prepared for one of these papers. The papers for which no abstracts were prepared are concerned with materials and processes not within the scope of NSA. (J.R.D.)

For abstract of individual paper see: 22031.

22031 ALLOYING BEHAVIOR OF THULIUM AND LUTETIUM WITH PLUTONIUM. Harbur, D. R.; Conner, M. R.; Anderson, J. W. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Foundrymen's Soc.; 77: 229-32(1969).

From 73rd Annual Meeting of the American Foundrymen's Society, Cincinnati, Ohio. See CONF-690560.

During the preparation of plutonium alloys containing less than 3% by weight of the rare earth (RE) metals, thulium or lutetium, difficulty was encountered in casting homogeneous alloys even though previous investigators had shown these metals to be soluble. Further evaluation of this problem revealed that the vapor-deposited Re feed materials had severe intergranular corrosion and a high oxide content. It was also found that the RE metals reacted with the walls of the oxidized tantalum melt crucibles producing more RE oxides. Only after removal of these RE oxides by double melting could homogeneous castings be made by standard plutonium foundry practices. (auth)

22032 QUALITY CONTROL, PROCESSING, AND INSPECTION FROM THE POINT OF VIEW OF THE STEEL PRODUCER. Sterne, Robert H. Jr.; Greenfield, Walter S. (Lukens Steel Co., Coatesville, Pa.). Nucl. Met., Met. Soc. AIME; 16: 153-77(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

Production processes are described and information is included on uses of steel products in nuclear systems, characteristics of plate products, melting processes, rolling heat treating, quality control, and special production procedures for clad steel. (J.R.D.)

22033 MATERIAL FORMING AND WELDING NUCLEAR PRESSURE VESSELS. Bunn, W. B.; Randolph, D. D. (Combustion Engineering, Inc., Chattanooga). Nucl. Met., Met. Soc. AIME; 16: 178-98(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

The manufacturers of nuclear pressure vessels have found their previous experience and methods of heavy-metal fabrication to be a good base, but inadequate for the nuclear industry. This has generally been the case for design, metallurgical, and welding technologies. Expansion of these technologies has been necessary in order that very large and sophisticated vessels could be built with the high degree of integrity required for nuclear service. To date, the light-water reactor systems appear to be favored when compared with the other types. However, the design requirements are demanding—especially the necessity of providing a practically full diameter opening and the close dimensional requirements. The latter requires the maintenance of close tolerances from the low pressure and temperature of startup operations to maximum service conditions. Fabrication techniques used by U. S. manufacturers of nuclear pressure vessels for light-water systems are reviewed. These are the systems of greatest commercial importance today. The techniques and processes used in their construction have been stabilized somewhat, although they may vary from one fabricator to another. (auth)

22034 THIN FILMS OF VANADIUM, NIOBIUM, AND TANTALUM. Karev, V. N.; Klyucharev, A. P.; Kovalenko, L. I.; Rozen, A. A. (Physical-Technical Inst., Kharkov). pp 87-91 of Fizika Metallicheskikh Plenok. /Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1969). (In Russian).

Methods of producing films of V, Nb, and Ta by vacuum decomposition of their volatile chlorides and iodides are described. Thermodynamics of these reactions are examined. Other work in which overstated values of decomposition points of these halides is noted. Data are included to show that the obtained results are in accordance with results of thermodynamic calculations. The procedures are given for obtaining films by vapor reduction of vanadium diiodide and the pentachlorides of Nb and Ta. (tr-auth)

22035 THIN FILMS OF RARE-EARTH METALS. Karev, V. N.; Klyucharev, A. P.; Lishenko, L. G.; Nazarova, T. S.; Rozen, A. A. (Physical-Technical Inst., Kharkov). pp 92-6 of Fizika Metallicheskikh Plenok. /Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1969). (In Russian).

A vacuum-thermal reduction method of producing thin films (1 to 10 μm) of Sm, Eu, Dy, Tm, and Yb is described and its efficiency is compared with existing methods which are briefly reviewed. A method of obtaining such thin films by reducing the corresponding oxides with La or Zr in the form of chips or shavings, the metal thereupon being evaporated and condensed on a cold substrate is described. (Metals Abstr.)

22036 ELECTROLYTIC METHOD FOR PRODUCTION OF METAL FOILS FOR NUCLEAR INVESTIGATIONS AND THICKNESS MEASUREMENTS. Karev, V. N.; Medyanik, V. N. (Physical-Technical Inst., Kharkov). pp 97-108 of Fizika Metallicheskikh Plenok. /Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1969). (In Russian).

An electrolytic method of preparing metal target foils for nuclear investigation is described. Quantities of 50 to 100 mg are required for the production of one target. For any particular metal there is an optimum electrolyte composition, optimum conditions of electrolysis, and optimum type of substrate. These are all set out in the form of tables for a large number of metals, together with an indication of the use factor and losses involved. Methods of measuring the film thickness are also included. (Metals Abstr.)

22037 PRESSING CHARACTERISTICS OF THE REFRACTORY METALS TANTALUM AND NIOBIUM. Chauzov, A. S.; Kazachenok, V. I. Kuznechno-Shtampovochnoe Proizvod.; No. 1, 15-16 (Jan 1970). (In Russian).

In order to investigate the possibilities of the wider use of pressing for Ta and Nb (instead of a pressing and machining process), experiments were carried out on the pressing of a large number of small thin-walled parts of Nb and alloy TN-3 (composition not given) which had properties near to those of pure Ta. The dimensions of the pressed parts were: dia 6 to 24 mm; height (0.5 to 1.5) × dia; and wall thickness 0.2, 0.3, and 0.4 mm. The parts were with flange, without flange, and step-shaped. The necessity for lubrication is emphasized (machine oil with a viscosity ~2.7 poise was used as a lubricant) and formulae are given for the lubrication gap between the billet and the die. (Metals Abstr.)

22038 DEEP DRAWING OF BERYLLIUM BRONZE: PROBLEMS IN PRODUCING LEAVES FOR BELLOWS. Budde, Joachim H. Werkstatt. Betr.; 102: 593-7(Sep 1969). (In German).

Methods used to derive tool dimensions, to determine the number and extent of intermediate anneals, and to fix appropriate cleaning treatments in the production of hollow shells with wall thickness of ~0.1 mm (±5 μm) of Cu–1.7% Be alloy are described. (Metals Abstr.)

22039 FABRICATION TECHNIQUES AND QUALITY OF ZIRCALOY CLADDING TUBES. Yamamoto, Haruo (Kobe Steel, Ltd., Japan); Okada, Takeshi; Onishi, Tadatoshi; Tanaka, Yoshiro. Kobe Seiko Giho; 20: No. 2, 12-20(Apr 1970). (In Japanese).

The Zircaloy cladding tubes produced by Kobe Steel Ltd. are superior in quality, compared with those by other countries in the world. The requirements for Zircaloy cladding tubes and the procedure adopted by Kobe Steel Ltd. are described, and various properties of the produced tubes are given. The requirements included corrosion resistance, compatibility with contained fuel, and strength against the internal pressure of fission product gas. The overall procedure consisted of hot extrusion to give high purity and uniformity, cold processing to provide accurate dimensions, good toughness, and finally inspection. A three-roller method used in the final process gave the highest difference between the reduction ratios of wall-thickness and outer-diameter. (Japan)

22040 METHODS FOR CLADDING LARGE SURFACES: WELDED AND ROLLED CLADDING. Lauprecht, Wolfgang; Theis, Erich. Schwissen Schneiden, 22: 123-8(Mar 1970). (In German).

The usual methods of manufacturing clad plate were by means of rolling or buildup welding. Base materials which were clad were DIN 17 100, 17 155, and 17 175, 10 CrMo 9 10, high-tensile and high-temperature special steels as well as Cr–Ni steels. Materials with better corrosion resistance used for cladding were ferritic Cr steels, austenitic Cr–Ni steels, Ni alloys, Ni–Cu alloys, Al, Ti, Ta, and Mo. The methods used are tabulated and are roll-cladding, build-up welding, and high energy rate cladding. Roll-cladding and build-up weld cladding are described and the effect of welding conditions and preheating, on the quality of the weld deposit in build-up cladding is discussed. The effect of Cr and Ni content in austenitic strip electrodes during submerged arc welding is also described. (Metals Abstr.)

22041 FABRICATION TECHNOLOGY AND QUALITY FOR ZIRCALOY FUEL-CLADDING TUBES. Yamamoto, Haruo (Kobe Steel, Ltd., Japan); Okada, Takeshi; Nagai, Nobuyuki; Tanaka, Yoshiro. Karyoku Hatsuden; 21: 217-22(Feb 1970). (In Japanese).

The quality of domestic Zircaloy fuel cladding tubes was improved even beyond that in the United States. The features of the established domestic technology and the quality and its control are described. The requirements for cladding tubes in general, and the production procedure for Zircaloy tubes are explained. The fabrication of the Zircaloy cladding tubes was accomplished by cold working. To improve the quality, it was necessary to have corrosion-produced zirconium hydride in the circumferential direction. The three techniques, draw bench, pilger roll, and three-roller roll, and the corresponding hydride behaviors, are described. Three-roller rolling was best for the hydride problem and resulted in superior surface, dimensional accuracy, strength, and toughness properties. (Japan)

22042 NEW POWDER METALLURGY. Pratt, Wilson N. West. Mach. Steel World; 61: 24-5(Apr 1970).

Powder-metallurgy parts, often strengthened by infiltration or the addition of alloying materials such as Ni or Mo, have a wide variety of applications, including porous bearings, carbide cutting tools, contacts, filters, and fuel cells. Recent developments such as the production of precision forgings from metal powder preforms and of high-strength parts from dispersion-strengthened materials should increase applications further. High-energy-rate tensile bars forged from Al, Ti, and 4620 steel preforms are illustrated. (Metals Abstr.)

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22043 TONS OF SUPERALLOY POWDERS. West. Mach. Steel World; 61: 32; 34(Apr 1970).

In the new rotating electrode process a rapidly rotating bar of material to be powdered was progressively melted by an electric arc. Centrifugal force spun molten droplets off the end of the bar into a controlled He atmosphere where they solidified. Particle size was primarily determined by the speed at which the bar rotated. Metal powders already produced in commercial lots include Al, Cu, Be, Ti, and U, while alloy powders include 7075 Al, Al–3% B, Al–10% Li, tool steels, 304 stainless, SAE 1018 and 1025 steels, Ti, U–Mo, and Zr. The free-flowing powders had a spherical shape, max bulk density, and high purity. Ultimate uses range from high-density sintered and extruded parts and mill shapes to controlled porosity structures. (Metals Abstr.)

22044 ELECTROCHEMICAL DEPOSITION OF A CADMIUM ALLOY. Janickis, J.; Pacauskas, E.; Saudargaite, A. (to Kaunas Polytechnic Inst.). Russian Patent 263,353. 4 Feb 1970. Filed 23 Feb 1968. (In Russian).

A Cd alloy was electrodeposited from an electrolyte containing $CdSO_4$ 9.0 to 10.2 g/l and H_2SO_4 to pH = 0. To obtain a uniform Cd–Se alloy coating, H_2SeO_3 1.3 to 1.8 g/l was added to the electrolyte and the deposition was at room temperature and current density of 5 to 15 mA/cm^2. (Selenium–Tellurium Abstr.)

22045 PRODUCTION OF ZIRCONIUM METAL BY ELECTROLYSIS IN MOLTEN FLUORIDES BATHS, THE CELL BEING FED BY TABLETS OF ZIRCONIUM OXIDE AND CARBON. Sheikh, Pervez A. (Pakistan Atomic Energy Commission, Karachi); Winand, R.; Fontana, A. J. Nucl. Mater.; 39: 84–92 (Apr 1971).

Small sintered tablets of ZrO_2 and carbon were prepared for additions to molten fluorides baths containing ZrF_4 and NaF, during electrolysis to produce zirconium metal. Two series of electrolysis with the fluorides baths containing NaF and ZrF_4 at different concentrations (10 and 20 mole % ZrF_4) were performed. The influence of the cathodic current density on the efficiency of utilization of tablets, the oxygen content of the metal recovered, and the current efficiency was studied for current densities of 50 to 600 A/dm^2. The investigations were completed by granulometric analyses of the metal powders obtained. The optimum current density which corresponded to a minimum of oxygen content of the metal was found to be at 200 A/dm^2, and the efficiency of utilization of tablets was found better in the bath containing 10 mole % ZrF_4. The minimum oxygen content of the metal prepared was at 2.06%, which was 31.1% lower than in the case of additions of free ZrO_2 to the molten electrolyte. (auth)

22046 JOINING DISSIMILAR MATERIALS. Tool. Prod.; 36: 103–8(Jun 1970).

Widely dissimilar materials can be graded, one into the other, by a new joining technique combining high-energy-rate forming and powder-metallurgy techniques to form a graded transition piece. The process was tested for combinations including Al to Ti, stainless steel to W and ceramics to various metals. The process took place at low temperature which prevented undesirable material interactions and produced a continuous gradation of material properties. (Metals Abstr.)

Properties Evaluations

Refer also to abstracts 21246, 21259–21262, 22167, and 22648.

22047 (BM-RI-7480) ELECTROTRANSPORT OF IMPURITIES IN RARE-EARTH METALS, USING A PULSED CURRENT. Marchant, J. D.; Shedd, E. S.; Henrie, T. A.; Wong, M. M. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Feb 1971. 13p.

Solid-state electrotransport of impurities in cerium, lanthanum, and praseodymium, using a pulsed current, was investigated. The results were compared with those of using a steady current. Impurities that showed appreciable movement with the pulsed current, but not with the steady current, were as follows: molybdenum and oxygen in cerium; aluminum, iron, and molybdenum in lanthanum. The use of a pulsed current enhanced the practical application of solid-state electrotransport to remove a wider variety of impurities from the host metals. (auth)

22048 (BMI–1896) PROGRESS ON LMFBR CLADDING, STRUCTURAL, AND COMPONENT MATERIALS STUDIES DURING OCTOBER–DECEMBER 1970. Quarterly Report. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Jan 1971. Contract W-7405-eng-92. 34p. Dep. NTIS.

Two sections are included on the development of mechanical property design data and studies on the effects of radiation on cladding and structural alloys. A separate abstract was prepared for each section. (R.C.K.)

For abstracts of individual sections see: 22049 and 22117.

22049 (BMI–1896, Sect.A) DEVELOPMENT OF MECHANICAL-PROPERTY DESIGN DATA FOR REACTOR MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 20p.

In Progress on LMFBR cladding, structural, and component materials studies during October–December 1970.

Low-cycle strain-controlled fatigue tests were conducted on solution-annealed Incoloy 800 specimens at 1000, 1200, and 1400°F. Eight specimens were tested with hold times at the tensile strain limit only. These specimens exhibited significantly lower fatigue lives than specimens tested earlier with no hold times. An analysis of the cyclically stable stress-relaxation curves for solution-annealed Incoloy 800 has been completed. Using this analysis it is possible to predict fatigue lives at lower strain ranges from data at higher strain ranges. Low-cycle strain-controlled fatigue tests have been initiated on Type 304 stainless steel. Four tests were conducted at 1000°F under continuous, fully reversed axial strain cycling. (auth)

22050 (DP-Report–584) METALLIC SPECIMENS TO BE EXPOSED TO THE COOLANT IN THE DRAGON REACTOR FOR MONITORING AND EXPERIMENTAL PURPOSES. Project DRAGON. Conde, J. F. G.; Dickson, J. G. (Atomic Energy Establishment, Winfrith (England)). Nov 1967. 23p. Dep. NTIS (U. S. Sales Only).

The possible locations in the Dragon Reactor in which experimental metallic specimens for corrosion or combined coolant compatibility/irradiation damage studies may be exposed are discussed and details are given of specimens which are at present in the reactor or are about to be inserted. The physical size, chemical composition and surface and heat treatment condition are indicated together with the weight and hardness of the specimens. In addition to the exposure of corrosion specimens for monitoring the reactor primary circuit in a spare viewing branch, three other locations are being employed for experimental specimens, two in the upper structure of the fuel elements and the third in a primary heat exchanger tube bundle. The proposed examination of the specimens subsequent to exposure is discussed briefly. (auth)

22051 (INIS-mf-7) DEFORMATION BEHAVIOR OF ZIRCONIUM–20 WT. PERCENT TITANIUM ALLOY. Dasgupta, P. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 1970. 5p. (CONF-700218-3). NTIS (U. S. Sales Only).

From Symposium on materials science research; Bangalore, India (24 Feb 1970).

An investigation was conducted on the deformation behavior associated with Zr-20Wt % titanium alloy over the temperature range 77 to 700°K. Both continuous tensile testing and stress relaxation experiments were employed to determine various parameters required to explore the possible dislocation mechanism operative in this alloy. The results of these measurements indicated that the thermally activated component of stress appeared to be unaffected by the alloying constituent while the athermal stress increased considerably as compared to unalloyed zirconium. Furthermore, two stages of activation were associated with this alloy. An attempt was made to identify various stages from the knowledge of the available dislocation rate controlling mechanism for deformation. (auth) (INIS)

22052 (LA–4584) BRAZE JOINT STRENGTH (REMELT TEMPERATURE VS VARIOUS STRESS LEVELS AND BEND TESTS). Koczan, Steven P. (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 20p. Dep. NTIS.

A strength evaluation is given of the braze alloys used to assemble the various components of the linear accelerator under construction at the Los Alamos Scientific Laboratory. (auth)

22053 (NRL–7220) EFFECT OF TENSION-COMPRESSION CYCLING ON FATIGUE CRACK GROWTH IN HIGH-STRENGTH ALLOYS. Crooker, T. W. (Naval Research Lab., Washington, D. C.). 27 Oct 1970. 11p.

Virtually all of the fatigue crack propagation data reported in the literature for structural alloys were generated under simple zero-tension cycling. The direct application of this data to problems involving large welded structures subjected to operating stress cycles approaching fully-reversed tension-compression was questionable. It showed that the compression portion of fully-reversed tension–compression cycling could contribute substantially to fatigue crack growth rates in plate-thickness,

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medium-to-high-strength alloys. Data from several alloys showed a 50 percent increase in fatigue crack growth rates due to tension–compression cycling. The implications of these findings and methods for applying the results of this study are discussed. (auth)

22054 (ORNL-TM-3294) DISCRETE ELEMENT ANALYSIS OF THE CREEP OF STAINLESS STEEL TUBING FOR LMFBR APPLICATION. Dewey, B. R. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 58p. Dep. NTIS.

As a specialized form of finite element stress analysis, the discrete element method was developed for hollow cylindrical solids subjected to pressure and thermal loading. The solution allows arbitrary radial variation of mechanical properties and temperature, is used to compute elastic and inelastic stresses and displacements, and to predict time-dependent deformation based on empirical creep laws. Particular attention is given to the analysis of stainless steel tubing typical of that used in the LMFBR, wherein the creep, stress relaxation, and stress rupture predictions are compared with experimental results. (auth)

22055 MONOTONIC AND CYCLIC MECHANICAL RESPONSE OF THE Ni–Ni_3Nb EUTECTIC COMPOSITE. Hoover, William Ringo. Bethlehem, Pa.; Lehigh Univ. (1970). 68p. University Microfilms Order No. 70-26,149.

Thesis.

The static and dynamic mechanical behavior of the Ni–Ni_3Nb eutectic composite was studied with tensile, compressive and fatigue testing, metallography and electron fractography. In order to more adequately understand the mechanical response of the composite, a study of the deformation and fracture behavior of the Ni_3Nb phase was found to deform primarily by twinning with little or no slip. Under tensile loading parallel to the [100] growth direction of the intermetallic, {112} deformation twins were formed which subsequently served as crack nucleation sites along the {112} twin boundaries. In addition, {001} twins developed when compression was applied parallel to the growth direction. Room temperature tensile testing of the Ni–Ni_3Nb eutectic composite produced uniform tensile strains in excess of 1%. This large composite ductility was attributed to extensive {112} twinning of the Ni_3Nb lamellae and subsequent twin boundary cracking. When amassed in sufficient numbers in a given cross-section, these {112} twin boundary fissures caused composite rupture. In an effort to more fully understand fatigue crack propagation in composite materials, tension-tension fatigue studies of the eutectic alloy were conducted. The Ni–Ni_3Nb composite displayed excellent fatigue resistance in a notched configuration by exhibiting an apparent endurance limit of about 55% of the 108 ksi smooth bar tensile strength. Under high stress-low cycle fatigue conditions, the fatigue resistance of the composite was controlled by the twinning and subsequent twin boundary fracture of the Ni_3Nb reinforcing phase. However, under low stress-high cycle fatigue conditions, Stage I crack propagation was observed in the Ni matrix; it was, therefore, concluded that the Ni matrix controlled the high cycle fatigue resistance of the composite. The fatigue behavior of the Ni–Ni_3Nb eutectic composite was compared with that of the Al–Al_3Ni eutectic composite. The similarity in the operative crack growth mechanisms in these two composites suggests a trend which may apply to all composite materials. (Diss. Abstr. Int., B)

22056 AN INVESTIGATION OF PLASTIC BEHAVIOR OF POLYCRYSTALLINE ZIRCONIUM IN THE TEMPERATURE RANGE 4.2^0 TO 1032^0K. Ramachandran, V. Gainesville, Fla.; Univ. of Florida (1970). 132p. University Microfilms Order No. 71-269.

Thesis.

This study was concerned with the plastic behavior of polycrystalline zirconium over the temperature range 4.2 to 1032°K. For the tensile tests at 4.2°K, both longitudinal and transverse specimens machined from a rolled zirconium plate were used. The metal exhibited higher ductility at 4.2°K than at room temerature. Prestraining transverse specimens at 4.2°K produced more room temperature damping capacity than prestraining at 77°K. All stress-strain curves in the 4.2°K tests exhibited characteristic sudden drops in the load, accompanied by audible clicks. Transverse specimens showed a much higher incidence of twinning, greater overall strain hardening, fewer serrations and more plastic deformation between serrations than longitudinal specimens. The load drops were related to thermal softening during deformation. At temperatures near absolute zero, the heat generated in a specimen during deformation was much more than that necessary to promote an instability and cause a consequent load drop. Hence it is postulated that all the heat generated is not retained in the specimen and a large fraction of it is lost to the surroundings. The experimental evidence suggested that the deformation during a load drop was localized. An estimate of the magnitude of the temperature rise in a typical load drop was made. The effects of recooling the specimen back to 4.2°K after a load drop were analyzed. Phenomena associated with dynamic strain aging were observed in coarse grained zirconium specimens during tensile conducted at elevated temperatures, at two strain rates differing by 3 orders of magnitude. At each strain rate, two peaks characteristic of dynamic strain aging were observed in the flow stress-temperature diagrams. These peaks were found to be strain rate dependent, shifting to higher temperatures with increase in strain rate. A minimum in the strain rate sensitivity of zirconium observed around 675°K was a consequence of the shift in the hardening peak temperature with changes in strain rate. At the temperature of the hardening peak, the tensile elongation of the zirconium specimens showed a minimum at each strain rate. The elongation minima did not reflect a true loss of ductility because the reduction in area did not pass through a corresponding minimum. At the temperature of the hardening peak, there appeared to be an increased tendency for neck formation in the tensile specimens. This could be rationalized in terms of variations in the strain rate sensitivity of zirconium caused by dynamic strain aging. (Diss. Abstr. Int., B)

22057 PRODUCTION OF METALLIC TECHNETIUM AND ITS PHYSICAL INVESTIGATION. Spitsyn, V. I.; Kuzina, A. F.; Tsarenko, A. F.; (and others). Radiokhimiya; 12: 617-21(1970). (In Russian).

High-purity metallic technetium was obtained in the form of a silver gray powder and in the form of compact metal beads, possessing the property of superconductivity with $T_{cr} = 8.2$°K. The technological system of production of the metal from tetraphenilarsonium pertechnate, corresponding to the formation of technetium dioxide in 1 hr, in an atmosphere of hydrogen at 260°C and of the metal at 1000°C, was determined. Physical investigations of its structure of an x-ray diffraction method established the presence of a hexagonal lattice with close packing of the atoms of the magnesium-type for metallic technetium, with parameters $a = 2.74 \pm 0.005$ and $c = 4.41 \pm 0.005$, $c/a = 1.609$. Radiometric and neutron activation methods of analysis revealed extremely low contents of impurities in the sample of the fused metal: Ru – 10^{-6}, Rh – 10^{-14}, Al – 10^{-5}, Na – 10^{-3}, and As – 10^{-3} g/g of Tc. No other impurities were detected within the limits of sensitivity of the neutron activation method. (tr-auth)

22058 EFFECT OF SMALL QUANTITIES OF VANADIUM AND TANTALUM ON THE STRUCTURE AND PROPERTIES OF NIOBIUM. Prokoshkin, D. A.; Vasil'eva, E. V.; Markova, S. A. Izv. Vyssh. Ucheb. Zaved., Mashinostr.; No. 6, 147-52(1970). (In Russian).

Microstructure, strength, and mechanical properties of Nb alloys with small additions of V and Ta (after extrusion and annealing) were studied at room temperature. Creep of alloys was examined at 1100°C and 8 to 16 kg/mm² tension. The effect of the distribution of the alloying elements on the structure of alloys containing V and Ta was determined by means of local micro-x-ray-spectral chemical analysis. The alloy with Ta had a higher heat resistance than the V alloy. This was due to a lower diffusion mobility and higher interatomic binding strength of Ta as compared to vanadium. (R.V.J.)

22059 STRENGTH OF SMALL DIAMETER POLYCRYSTALLINE TUNGSTEN WIRES. Garber, R. I.; Fedorova, L. I. (Inst. of Physics and Tech., Moscow). Fiz. Metal. Metalloved.; 30: 648-9(1970). (In Russian).

The relationship between the strength and diameter of isostructural polycrystalline wires was studied using a tungsten wire with an initial diameter of 0.2 mm and specimens electrolytically thinned to a diameter ranging from 1 to 100 μ for a 1 to 2 mm section. The results revealed an identical strength for the wires with 0.2 mm diameter and the thinned specimens. The observed independence of the strength from the diameter (at the examined magnitudes) was related to the electrolytic polishing method which did not disturb either the physical properties or the bond between the grains of the examined wires. (R.V.J.)

22060 TENSILE PROPERTIES OF HASTELLOY N WELDED AFTER IRRADIATION. McCoy, H. E. (Oak Ridge National Lab., Tenn.); Gunkel, R. W.; Slaughter, C. M. Weld. J. (N. Y.); 50: 71s-6s(Feb 1971).

Fusion welds affecting 75% of the cross section were made in small tensile samples (0.125 in. in diameter) of Hastelloy N irradiated to thermal fluences up to 9.4×10^{20} neutrons/cm². All of the unirradiated samples and 67% of the irradiated samples were satisfactorily welded using a specialized technique developed for this program. Surface contamination was suspected to be the cause of the unsuccessful welds in the irradiated samples. The welded irradiated samples generally had as good tensile properties at 25 and 650°C as the irradiated base metal. The weld metal deformed appreciably at 650°C and made a significant contribution to the overall fracture strain. The fracture location in the irradiated samples tested at 650°C shifted from the weld

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metal to the base metal following the postweld anneal of 8 hr at 870°C. The porosity which was observed near the fusion line of the irradiated samples probably results from transmuted helium bubbles, but this did not seem to affect the location of the fracture. (auth)

22061 ACCELERATION OF LIQUID MERCURY EMBRITTLEMENT OF TITANIUM ALLOYS BY ULTRASONIC OSCILLATIONS. Chen, C. M. (Ohio State Univ., Columbus); Kirkpatrick, H. B. Corrosion; 26: 559-60(Dec 1970).

Ultrasonic oscillations were found to markedly accelerate the fracture in liquid mercury of Ti-8Al-1Mo-1V and Ti-6Al-4V alloys. Unalloyed RMI 70 titanium was unaffected. Likewise, fracture by CH_3OH-HCl-H_2O solution was unaffected. The results are taken as indicating a stress-sorption failure mechanism. (auth)

22062 TITANIUM AS AN ENCASEMENT FOR ^{60}Co WITH SPECIAL REFERENCE TO A PNEUMATIC AFTERLOADING THERAPY UNIT. Breed, J. Ernest; Ho, Chieh; Breed, David S. (Northwestern Univ., Chicago). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 111: 401-4(Feb 1971).

The advantages of using Ti instead of stainless steel for encapsulating small ^{60}Co sources for medical radiation therapy are discussed, and its use in a new afterloading remote controlled unit in the form of small ball-bearings, $\frac{1}{8}$ in. in dia with 1 mm^3 of radioactive ^{60}Co in the center, is described. It is concluded that Ti is hard, tough, chemically resistant, lightweight, and particularly suitable for the encapsulation of small ^{60}Co sources which are irradiated after encapsulation and which can be transported in pneumatic tubes. (L.C.L.)

22063 STRENGTH-TOUGHNESS PROPERTIES OF WELDS IN PLATES OF COMMERCIAL TITANIUM ALLOYS. Stark, L. E. (Babcock and Wilcox Co., Alliance, Ohio). Weld. J. (N. Y.); 50: 58s-70s(Feb 1971).

The strength, toughness, and hardness properties were determined for multipass welds deposited by gas tungsten-arc welding in plates of commercial and semi-commercial titanium alloys. A rating in order of decreasing Charpy V-notch impact toughness is given. High purity titanium with very low hydrogen had 60 ksi ultimate strength and 150 to 190 ft lb toughness at room temperature. Ti-6Al-2Nb-1Ta-1Mo with an ultimate strength range of 125 to 150 ksi had corresponding toughness of 45 to 20 ft lb. The alpha and near-alpha alloys ranging from 85 to 150 ksi ultimate strength had corresponding toughness of 55 to 10 ft lb. The alpha-beta alloys ranging from 100 to 165 ksi ultimate strength had corresponding toughness of 45 to 5 ft lb. The commercially-pure grades with ultimate strength from 60 to 120 ksi and toughness ranging from very great to less than 5 ft lb had progressively decreasing toughness with increasing hydrogen content. The beta and near-beta alloys with ultimate strengths above 110 ksi and capable of heat treatment to very high strength levels had very low toughness of less than 10 ft lb. The strength-hardness properties followed a predictable relationship similar to that developed by steel with the exception of several beta alloys. (auth)

22064 COMBUSTION OF ZIRCONIUM DROPLETS IN OXYGEN/RARE GAS MIXTURES. Nelson, Lloyd S. (Sandia Labs., Albuquerque, N. Mex.); Levine, Herman S.; Rosner, Daniel E.; Kurzius, Shelby C. High Temp. Sci.; 2: 343-75(Dec 1970).

The combustion of single submillimeter droplets of zirconium in oxygen-rare gas mixtures was studied by pulse-heating squares of high-purity foil with the radiant emission from a flash lamp or laser. By allowing the droplets to fall freely through the oxidizing environment during combustion, contamination and other effects of containment or support materials were avoided. The transient burning phenomena were studied by means of the luminosity-time behavior of the droplet and by microanalysis of solidified droplets quenched at various stages of oxidation. During the combustion, the composition of the droplets progressed from Zr to ZrO_2 at rates that depended on the conditions of oxidation. Concurrently, the luminosity-time records showed four successive stages. After complete combustion in oxygen-rich atmospheres, the droplets gained weight to a value that corresponded to essentially stoichiometric ZrO_2. This gain indicated conservation of the original zirconium even though the reaction temperature approached the boiling points of both the metal and oxide. In contrast, the droplets lost metal when the concentration of oxygen was lowered, even though the burning temperature decreased. In pure oxygen over a wide range of pressures, weight loss and the size of the luminosity hump in the second stage appeared to correlate inversely. In oxygen-rich atmospheres, the burning reaction was accompanied by a swirling, spherical fog layer of condensing oxide droplets which may agglomerate into a larger droplet that follows in the wake of the falling parent droplet. Periodically, the follower droplet grew large enough to touch the parent and coalesce with it. The observed conservation of metal is attributed to this condensation and coalescence mechanism. The luminosity increased upon superficial solidification of the zirconia end-product of the reaction occurred in a time interval of about 50 μsec. Immediately thereafter luminosity decreased steadily, i.e., no halt appeared. This abrupt brightening was attributed to the release of the latent heat of fusion at an inward-growing crystallization wavefront. The fall-distance history of burning zirconium droplets was shown to depend on the conditions of combustion and particularly on the presence of the fog layer. (auth)

22065 HIGH-PERFORMANCE MATERIAL FROM A HOT-WORKED SUPERALLOY POWDER. Friedman, Gerald; Kosinski, Edward (Whittaker Corp., West Concord, Mass.). Metals Eng. Quart.; 11: No. 1, 48-50(Feb 1971).

Experimental data showed clearly that good mechanical properties, coupled with superior metallurgical structure, could be achieved in a complex nickel superalloy made from high quality powder. The mechanical property tests demonstrated that high tensile strength was achieved with no sacrifice in ductility. The uniformity in structure and the narrow band of properties for the powder specimens also indicated that it should be possible to design with greater confidence or to specify higher working stresses with hot worked powder versions of the high-temperature alloys. Work is now in progress whereby subscale and full-size gas turbine discs and other critical engine parts are being formed from hot-worked superalloy powders. It will be only a short time before such powder parts will be flying in advanced high-performance aircraft. (auth)

22066 THERMAL CONDUCTIVITY OF CADMIUM AND CADMIUM-ALLOY CRYSTALS. Bogaard, R.; Gerritsen, A. N. (Purdue Univ., Lafayette, Ind.). Phys. Rev., B; 3: 1808-16 (15 Mar 1971).

The intrinsic thermal resistivities W_i of pure Cd and Cd–Zn single crystals with residual-resistance ratios in the range $5 \times 10^4 - 570$ (Zn content up to 0.56 at.%) were determined for both hexagonal and basal orientations in the temperature range $3 < T < 100$°K. One Cd–Sn crystal (0.14 at.% Sn) was measured in the basal orientation. The data are represented by $W_i \propto T^n$. In the case of pure Cd, $n = 2$ for $T < 3.5$ K, whereas for the most impure alloy, $n = 2$ for $T < 13$°K. For temperatures above the $n = 2$ region, n was found to be as large as 4.5 in the interval $4° < T < 7$°K in the case of the purest crystal. The known rapid change of the specific-heat Debye Θ does not explain the large n. This indicates a small to negligible interaction between the electrons and transverse phonons. The region where $n > 2$ is, in general, in the temperature range where phonon scattering outweighs impurity scattering. It is suggested that because of the particular shape of the Fermi surface, umklapp processes may be important in and above the temperature range where n is large. (auth)

22067 INFLUENCE OF CONDUCTING UNDERPLAYS ON THE PROPERTIES OF SPUTTERED TANTALUM FILMS. Westwood, W. D. (Northern Electric Research and Development Labs., Ottawa). Thin Solids Films; 6: 307-20(Nov 1970).

Tantalum films have been deposited in a dc diode sputtering system on glass and polycrystalline alumina substrates. The effects on the films due to the presence of gold and carbon layers on these substrates has been investigated for different discharge currents and film thicknesses. The layers do not effect the properties of the films if the layers cover small areas of the substrates and are electrically isolated from the anode. However, layers which cover the whole substrate and are electrically connected to the anode encourage the formation of the phase of tantalum rather than the tetragonal β-phase. While this effect is greatest in films deposited on top of carbon layers, it is also present in films deposited at the same time on adjacent bare substrates. (auth)

22068 R. F. SPUTTERED TANTALUM FILMS DEPOSITED IN AN OXYGEN DOPED ATMOSPHERE. Baker, P. N. (Edwards High Vacuum International, Crawley, Eng.). Thin Solids Films; 6: R57-60(Nov 1970).

The electric and structural properties of Ta films obtained by rf sputtering in argon doped with various concentrations of oxygen are described. (J.R.D.)

22069 TECHNOLOGY OF PRESSURE-RETAINING STEEL COMPONENTS. Proceedings of the Symposium, Vail Village, Colorado, September 21–23, 1970. Wechsler, Monroe S. (ed.). Nuclear Metallurgy, Volume 16. New York; Metallurgical Society (1970). 318p. (CONF-700935).

Twenty papers were presented at the conference. Five papers were not included in the conference proceedings. One paper appeared in NSA as 25: 6856. A separate abstract was prepared for each of fourteen papers. (J.R.D.)

For abstracts of individual papers see: 21259–21261, 22032, 22033, 22070–22077, and 22122.

22070 STATUS OF PIPE RUPTURE STUDY. Vandenberg, S. R. (General Electric Co., San Jose, Calif.). Nucl. Met., Met. Soc. AIME; 16: 20-38(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

The pipe rupture study was designed to extend the understanding of failure-causing mechanisms and to provide improved capability for evaluating reactor piping systems to minimize the probability of failures. Following a detailed review to determine the effort most needed to improve nuclear system piping (Phase I), analytical and experimental efforts (Phase II) were started in 1965. The accomplishments in five years of a broad program are summarized on fatigue studies through both bench-scale and large-component tests, at-reactor tests of the effect of primary coolant environment on the fatigue behavior of piping steels, fracture mechanics, solution of problems in stress analysis, and failure probability study of actual reactor piping systems. (auth)

22071 SOME ASPECTS OF RECENT PRESSURE-VESSEL RESEARCH AND DEVELOPMENT WORK IN THE UNITED KINGDOM AND EUROPE. Nichols, R. W. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Nucl. Met., Met. Soc. AIME; 16: 49-76(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

Outlines of recent work and the locations in which it is being done are presented. Information is included on the pressure vessel industry in Europe, pressure vessel research in the UK, stress analysis, creep, brittle and fast fracture, and fabrication and inspection. (J.R.D.)

22072 CHARACTERIZATION OF CARBON AND LOW ALLOY STEELS FOR PRESSURE VESSELS. Stout, R. D.; Pense, A. W. (Lehigh Univ., Bethlehem, Pa.). Nucl. Met., Met. Soc. AIME; 16: 77-96(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

The use of low-alloy steel compositions and heat treatment has made available a group of steels for heavy-section pressure vessels of higher strength and improved notch toughness than can be obtained from carbon steel grades. In addition they have the potential of developing higher fatigue strength and of application over a wider range of temperatures. If full advantage is to be taken of the steels, a proper understanding is necessary of their responses to fabrication operations. For example, loss of ductility and notch toughness may be induced by cold forming, welding, or exposure to certain temperature ranges. The higher strength steels are more sensitive to loss of fatigue strength resulting from discontinuities produced during fabrication. Consequently more elaborate precautions are generally essential to the satisfactory production of high-strength pressure vessels. (auth)

22073 DYNAMIC FRACTURE CHARACTERISTICS OF THICK SECTION STEEL. Loss, F. J. (Naval Research Lab., Washington, D. C.). Nucl. Met., Met. Soc. AIME; 16: 98-118(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

Operating limits for commercial reactor pressure vessels are often selected to take advantage of the brittle-to-ductile fracture toughness transition which has been observed to evolve above the NDT temperature for thin section, low alloy steels. Linear elastic fracture mechanics (LEFM) data obtained with thin sections and extrapolated to project thick section fracture behavior have raised concern that this transition to high ductility may be severely depressed or eliminated near reactor operating temperatures. Research programs emphasizing thick-section dynamic tear (DT) studies and those relating to thick-section LEFM investigations were undertaken to resolve this question. These studies have shown that thick-section steels of shelf toughness and strength class similar to A533-B continue to exhibit a significant toughness transition within a relatively narrow temperature interval above NDT. Size-effect results using the DT test indicate that the mechanical constraint associated with a 12-in. thick section elevates the corresponding FTE temperature approximately 70°F above that for thin sections. For the steels investigated the DT energy curve may be divided into three toughness regimes which are shown to indicate similar transition features for specimens of $\frac{5}{8}$-in. to 12-in. thickness. Regime 1 defines a temperature interval of relatively brittle behavior which can be analyzed with dynamic LEFM methods. Regime 2 defines a transition region which must contain the FTE temperature requiring yield stress levels for fracture propagation. Regime 3 defines a region near the DT shelf temperature in which gross plastic deformation is required to promote fracture. (auth)

22074 FRACTURE MECHANICS APPROACH TO RELIABILITY IN NUCLEAR PRESSURE VESSELS. Wessel, E. T.; Mager, T. R. (Westinghouse Electric Corp., Pittsburgh). Nucl. Met., Met. Soc. AIME; 16: 119-52(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

The applicability of fracture mechanics technology for assuring the reliability of large nuclear pressure vessels is described in terms of the basic concepts involved, the type of information required to use the technology, the information currently available, and how this information is employed to ensure the desired integrity in the vessels. The interdisciplinary nature of the technology is illustrated with example problems, one of which emphasizes the general procedures, and a second which encompasses all the considerations involved in the 40 year service life of a vessel, including irradiation effects. It is concluded that the technology is well established and much of what remains to be done falls in the category of modification and refinement. Engineers are urged to put this technology to practical use in solving reliability problems. (auth)

22075 FAST FRACTURE TESTS OF LARGE TENSILE SPECIMENS. Grigory, Stephen C. (Southwest Research Inst., San Antonio). Nucl. Met., Met. Soc. AIME; 16: 218-31(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

Activities are reported in a program to study the effects of flaws on heavy-section steels. Two specimens have been tested above 200°F and considerable data have been obtained. However, the procedure for producing the artificial flaw has not been finalized and the tests of specimens at temperatures below 200°F have been delayed for this reason. The sharpness of the leading edge of the machined notch was not considered significant at temperatures above 200°F. The leading edge of notches in future specimens will be sharpened by fatigue even though considerable time is required for this process. The third large tensile specimen will be subjected to a cyclic three-point bending load to produce the fatigue crack. However, efforts are also being made to produce a fatigue crack by applying pressure to the notch cavity and this method, if successful, will produce considerable savings when sharpening flaws. (auth)

22076 EXPERIMENTAL STUDY OF FRACTURE BEHAVIOR IN REACTOR COOLANT PIPING. Eiber, Robert J.; Maxey, Willard A.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Met., Met. Soc. AIME; 16: 232-49(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

An experimental study was conducted on A106B and Type 316 primary coolant piping to examine the fracture behavior of artificial axial flaws under simulated operating temperature and pressure conditions. The extent of fracture propagation has been investigated and the conditions for a leak and a rupture have been defined and shown to be predictable. In addition, an arrest stress level has been identified for a ductile fracture. The arrest stress level is the minimum stress level required to support shear fracture propagation. The experiments have provided experimental data on the size of part-through and through-wall critical flaw sizes required to initiate fractures. Also, analytical formulations have been developed to predict critical flaw sizes. The effects of crack orientation are discussed. No experiments have been conducted on circumferential flaws, but based on the data from other experimental programs involving circumferential flaws a critical crack formulation has been hypothesized and is discussed. (auth)

22077 FATIGUE CRACK GROWTH IN PROTOTYPE PIPING AND COMPONENTS. Kiss, E.; Heald, J. D.; Hale, D. A. (General Electric Co., San Jose, Calif.). Nucl. Met., Met. Soc. AIME; 16: 292-309(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

Results of testing and evaluation of the crack growth of prototype piping components subjected to low cycle fatigue are presented. The specimens were fabricated from materials used for the primary piping of pressurized water (PWR) and boiling water (BWR) nuclear reactor systems. Data were obtained for through-wall and circumferential crack growth at room temperature and 550°F. Comparisons are made of crack growth data obtained from the prototype piping and laboratory tests of flat plates of similar materials. Data are included which show that piping components at BWR operating pressure, subjected to continued low cycle

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fatigue loading, are almost certain to leak rather than fracture suddenly. (auth)

22078 MICROSTRUCTURE AND PROPERTIES OF ALUMINUM ALLOYS AFTER RAPID SOLIDIFICATION. II. EXTENSION OF SOLID SOLUBILITY, INFLUENCE OF THERMAL TREATMENTS, MECHANICAL PROPERTIES. Furrer, Peter; Warlimont, Hans (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 62: 100-12(Feb 1971). (In German).

Extremely rapid quenching from the melt resulted in a metastably extended solid solution in different Al alloys. The decomposition of these highly supersaturated solid solutions began only at comparatively high temperatures. The considerable improvement of the mechanical properties of rapidly solidified alloys is due to different strengthening mechanisms. Such materials may assume practical importance, e.g., as base materials in powder metallurgy. These features are discussed on the basis of published results. (auth)

22079 EFFECT OF NITROGENATION ON THE MECHANICAL PROPERTIES OF NIOBIUM. Kiparisov, S. S.; Levinskii, Yu. B.; Strogonov, Yu. D. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 125-8(1970). (In Russian).

The effects of nitrogenation on the mechanical properties of Nb, including short-term tensile strength at failure by cracking, plasticity, and hardness were studied. The optimum condition for nitrogenation of Nb is 1100 ± 2 to 3°C. The hardness obtained by such treatment is 230 to 240 HV at the surface and 210 to 220 HV at 100 mm below the surface. Annealing of cold hardened Nb at 1100°C for 1 hr leads to a decrease in Σ_B phase having an indent value of 32 to 63 kg/mm^2. Annealing in vacuum at 1200°C for 1 hr of material which had been subjected to nitrogenation at 1200°C, produced a Σ_B phase with an indent value of 52 to 63 kg/mm^2. (tr-auth)

22080 ELASTIC CHARACTERISTICS OF TUNGSTEN AND MOLYBDENUM SINGLE CRYSTALS. Dreshpak, V. A. Probl. Prochnosti; No. 6, 102-4(Dec 1969). (In Russian).

Young's modulus (E), shear modulus (G), and Poisson's ratio (μ) were determined, by a resonance method, for single crystals of W [100] and Mo [111] in the temperature range 20 to 2600°C in a vacuum. The results are discussed in relation to values obtained previously and those for polycrystalline materials. (Metals Abstr.)

22081 ELECTROSINTERING OF ALUMINIUM, BERYLLIUM, AND TITANIUM ALLOYS FROM THEIR POWDERS. Alluminio; 39: 143-4(Mar 1970). (In Italian).

Details are given of a range of electrosintering machines in which the compact was simultaneously compressed and heated by direct-resistance heating. The power of the machines varied from 35 to 1050 kVA. The mechanical properties of a series of Al, Be, and Ti alloys, as sintered and subsequently heat-treated, are given. Densities of 98 to 100% theroretical are obtained and properties are correspondingly high. (Metals Abstr.)

22082 NEW MATERIALS FOR HARD-FACING. Folkhard, Erich. Schweissen Schneider, 22: 245-8(Jun 1970). (In German).

Hardness and toughness are important properties with regard to wear but during recent years the importance of corrosion often coupled with wear has been stressed. New hard-facing materials are described which have good wear-corrosion resistance e.g., Ni, Ni–Cu, Ni–Cu–Mo, Co–Cr–W–Mo, Ni–Cr–Mo–Cu, and Cu–Ni–Si–Zn. The properties of sintered W carbides used as welding rods for these alloys are described. Other materials of special importance are the corrosion-resistant steels containing Cr 13% and Ni 4 to 6%; their mechanical properties are described. These steels have high strength and toughness coupled with a low degree of susceptibility to cracking. (Metals Abstr.)

22083 RELATIONSHIP OF DUCTILITY AND STRENGTH TO TEMPERATURE FOR ERBIUM. Sokolov, L. D.; Skudnov, V. A.; Gladkikh, A. N. Probl. Prochnosti; No. 6, 104-5(Dec 1969). (In Russian).

Experiments were carried out to determine the tensile strength, relative elongation, and compressibility of Er at −96 to 966°C. High-purity (98.8%) Er was used, the specimens being heated in an Ar atmosphere. The results are presented graphically and discussed. (Metals Abstr.)

22084 INVESTIGATION OF MECHANICAL PROPERTIES OF NEW TITANIUM ALLOYS AT LOW TEMPERATURES. Koshelev, P. F.; Mikheev, V. S.; Nikitin, P. N. Probl. Prochnosti; No. 2, 40-5(Feb 1970). (In Russian).

The behavior of binary and multi-component Ti alloys in the temperature range +20 to −253°C was investigated. With decreasing temperature the strength of Ti–V and Ti–Nb alloys increased and their ductility decreased. In the case of Ti–Ta alloy both the strength and ductility increased with decreasing temperature down to −196°C, where ductility started to decrease. Tests on notched specimens showed that Ti–V and Ti–Nb alloys were more sensitive to decreases in temperature than Ti–Ta alloy. The strength of the ternary alloy Ti–Ta–V slightly increased with increasing content of Ta and V. For concentrations of Ta and V in the alloy exceeding 6 to 7 wt% the increase in strength was more pronounced (due to precipitation of β-phase). Ti–Ta–V–Mo alloys with α-structure possessed optimum mechanical properties and, compared with the Ti alloys mentioned above, display higher resistance to brittle fracture at low temperature. (Metals Abstr.)

22085 STUDY OF THE OXIDATION OF ALPHA–ZIRCONIUM IN DRY OXYGEN BY INTERFERENCE SPECTROMETRY AND THERMOGRAVIMETRY. Cammarota, G. P.; Palombarini, G.; Morettini, L.; Servidori, M.; Stremmenos, C. Electrochim. Metal.; 4: 319-38(Oct-Dec 1969). (In Italian).

The kinetics of oxidation of α-Zr in dry O (at 800 torr) were determined at 450 and 520°C using interference spectrometry and at 750 and 850°C using a thermal balance. At 450 and 520°C thin film oxidation initially occurred at a constant rate which decreased after the formation of a min film thickness, ~4000 Å. The total weight gain at 750 and 850°C, including O in solution, followed a parabolic law. X-ray diffraction indicated phase changes in the ZrO_2 layer which were related to the oxidation mechanism. (Metals Abstr.)

22086 CAST NICKEL-BASE ALLOYS. Efimova, M. N.; Masoleva, E. N. Liteinoe Proizv.; No. 10, 1-3(Oct 1969). (In Russian).

Tests are reported on four new alloys: M20VC, containing Al 5 and Ti 5%; 713C, containing Al 6.0, Ti 1.0, and Nb 2%; M22VC, containing Al and Ta in unspecified amounts; and MC 103, containing Nb 8.0%. Alloy MC 103 had an impact strength 8.4 kg.m/cm^2 and the other three alloys 3.4 to 3.8 kg/cm^2, with 0.2% proof stress 77 to 83 kg/mm^2 and UTS 92 to 94 kg/mm^2. The microstructure and casting properties were studied in the laboratory and in gas-turbine engine guide vanes. The high-Al vanes should operate up to 950°C, and the other two alloys up to 850 to 900°C for periods up to 11 000 hr. (Metals Abstr.)

22087 INFLUENCE OF PURITY AND STABILITY OF THE ENVIRONMENT ON THE LONG-TERM STRENGTH AND CREEP OF REFRACTORY ALLOYS. Bulygin, I. P.; Nekrasov, N. D.; Zhabina, V. A.; Efremova, G. A.; Mostovoi, G. E. Probl. Prochnosti; 2: No. 5, 38-42(May 1970). (In Russian).

Results are given of a comparative study of the strength and creep properties of Nb alloy VN-2 and Mo alloy VM-1 in vacuum (10^{-8}, 10^{-4}, and 10^{-2} torr) and in fairly pure Ar at 1100 to 1200°C. The properties were affected appreciably by the environment. Suggestions are made for guaranteeing the reliability and reproducibility of experimental results. (Metals Abstr.)

22088 HIGH TEMPERATURE SPECIFIC HEAT OF REFRACTORY COMPOUNDS. Hoch, M. (Univ. of Cincinnati). Rev. Int. Hautes Temp. Refract.; 7: 242-6(Jul-Sep 1970).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

The high temperature specific heats of molybdenum and uranium dioxide were examined. For both materials, the data can be represented by an equation of the type $C_p = 3\,RF(\theta_d/T) + cT + dT^3$ between θ_D (the Debye temperature) and the melting point. In the case of molybdenum, this equation accurately represents the data within ten degrees of the melting point. Exponential terms, which would be necessary to account for the formation of vacancies can give significant contribution to its specific heat only within the last ten degrees of the solid range. In the case of uranium dioxide, the coefficient c of the linear term of the above equation is zero, since there is no electronic contribution to the specific heat. (France)

22089 APPARATUS FOR HIGH TEMPERATURE THERMAL DIFFUSIVITY MEASUREMENTS. Weilbacher, Jean-Claude; Van Craeynest, Jean-Claude (CEA, Fontenay-aux-Roses, France). Rev. Int. Hautes Temp. Refract.; 7: 268-70(Jul-Sep 1970). (In French).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

A device was developed for thermal diffusivity measurements in nuclear fuels under a gas atmosphere between 0 and 3 bars at 1,000–3,000°C. This apparatus is an adjustment of the flash method to very high temperatures. The samples are heated with h-f induction. The excess heat input necessary for diffusivity

measurements is brought by a laser; the corresponding temperature variations are simultaneously recorded by an optical pyrometer and by a photomultiplier. (auth) (France)

22090 MEASUREMENT OF THERMAL DIFFUSIVITIES USING A PULSED ELECTRON BEAM. Walter, A. J.; Dell, R. M.; Burgess, P. C. (Atomic Energy Research Establishment, Harwell, Eng.). Rev. Int. Hautes Temp. Refract.; 7: 271-7(Jul-Sep 1970).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

A versatile apparatus was developed for measuring thermal diffusivities at 40 to 1,400°C. The specimen is mounted in a vertical tubular resistance furnace. An incident energy pulse upon the upper surface of the specimen is supplied by means of a focused electron beam. Square-shaped electron pulses are generated at potentials up to 20 kV and with a wide range of beam currents (10 to 50 mA). The temperature of the specimen rear surface is monitored by a divided thermocouple or by an infrared detector. Measurements were made on a number of different metals and ceramic materials at temperatures up to 1,400°C. Results for Fe and UO_2 are presented. (auth) (France)

22091 MULTI-PROPERTY APPARATUS AND PROCEDURE FOR HIGH TEMPERATURE DETERMINATIONS. Powell, R. W.; Taylor, R. E. (Purdue Univ., Lafayette, Ind.). Rev. Int. Hautes Temp. Refract.; 7: 298-304(Jul-Sep 1970).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

The direct electrical heating methods used in the determination of thermal properties at high temperatures were investigated. The apparatus and procedures are described and typical results given for tungsten to 2,700°K. Thermal conductivity was determined to within ±5%, electrical resistivity to ±1%, total hemispherical and spectral emissivity to ±2%. Lorenz function and Thomson coefficient were measured. (auth) (France)

22092 MATERIALS WITH PROTECTIVE [DIFFUSION] COATINGS AND THE ESTIMATION OF THEIR WORK CAPACITY. Kozub, Yu. I. Probl. Prochnosti; 2: No. 5, 43-8(May 1970). (In Russian).

The special characteristics of materials with protective surface layers are discussed. Results are presented of a study of the mechanical properties of Mo with various surface layers, Si–B, Si, B, and Cr formed by a diffusion method, and also of the protective properties of these layers in the temperature range up to 1400°C. Means of estimating the life of layers under high-temperature oxidizing conditions are considered and a method is given for making engineering calculations for construction parts made from such materials. (Metals Abstr.)

22093 THERMOPHYSICAL PROPERTIES OF LIQUID LEAD–CADMIUM ALLOYS. Volk, Charles Edward. Lafayette, Ind.; Purdue Univ. (1970). 248p. University Microfilms Order No. 71-2705.

Thesis.

Experiments were carried out to measure the electrical resistivity and thermal diffusivity of liquid alloys of the lead-cadmium system as a function of temperature and composition. The relation between electrical and thermal conductivity in liquid metals was also studied as a function of temperature and composition, using the experimental data. Measurements of electrical resistivity were made with a dc four-probe technique. An unsteady state method was developed for measuring the thermal diffusivity. The temperature range studied was 350° to 600°C for most alloys. Alloys covering the entire range of composition were investigated. The results of these measurements were interpreted in terms of existing theories of electronic conduction in liquid metals. The measured electrical resistivities of liquid lead, cadmium, and lead-cadmium alloys were generally consistent with data previously reported in the literature. The resistivities of lead-cadmium alloys varied parabolically with atom fraction of lead as predicted by the fluctuation scattering model of Taleuchi and Endo. The thermal diffusivities, determined by the unsteady state method, showed considerable scatter, with standard deviations of 5 to 10% for dilute alloys and 15 to 20% for intermediate compositions. Within this scatter, the thermal diffusivity was nearly a linear function of atom fraction lead. The thermal diffusivities at 350°C were substantially in agreement with values predicted from the electrical resistivities using the Wiedemann–Franz law, except for the liquid alloy of 35.4 at. % lead for which the observed thermal diffusivity was about 30% higher than predicted. However, at all compositions the thermal diffusivity increased more rapidly with temperature than predicted by the Wiedemann–Franz law. The composition region around 30 to 40 at. % lead exhibits maximum departures from ideal or linear behavior in several properties, including the temperature coefficient of resistivity, the thermal diffusivity and its temperature coefficient, and the entropy of formation of the solution. (Diss. Abstr. Int., B)

22094 INFLUENCE OF ZIRCONIUM DIOXIDE DISPERSIONS ON NICHROME DENSITY DURING SINTERING. Antsiferov, V. N.; Polyakov, V. A. (Perm Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 104-9(1970). (In Russian).

Compression and sintering of Nichrome with ZrO_2 was studied using powdered zirconium dioxide and powdered Nichrome (with the composition of 21.73 wt % Cr, 0.02 Ti, 0.07 C, 0.08 Si, 0.09 Fe, 0.05 Mn, and 0.004 S) that was preliminarily annealed for 2 hr in hydrogen at 900°C. Nichrome was compressed into bricks and sintered in hydrogen at 1100, 1200, and 1300°C. The relative density of Nichrome bricks containing up to 4% ZrO_2 was reduced at all temperatures. The ZrO_2 dispersion did not affect the size of the blocks but reduced the size of the grains. (R.V.J.)

22095 METALLOGRAPHY OF SUPERALLOYS. Kohlhaas, Erich; Fischer, Alfred (Roechling'sche Eisen- und Stahlwerke GmbH, Voelklingen, Ger.). Prakt. Metallog.; 8: 3-25(Jan 1971). (In German and English).

The complex composition of superalloys and their use over large ranges of temperature sometimes for long periods results in an extraordinary diversity of structural components. In order to obtain as comprehensive a picture as possible of the structure it is necessary to employ all available light and electron microscope methods supplemented by x-ray and diffraction pictures and electron beam microprobe measurements. The metallographic preparative techniques were illustrated by the examples of only a few materials. (auth)

22096 BERYLLIUM: THE INDUSTRIAL MATERIAL FOR AIR- AND SPACEFLIGHT. Gerhard, F. (Messerschmitt-Boelkow-Blohm GmbH, Munich). Luftfahrttech.-Raumfahrttech.; 16: 243-7(Oct 1970). (In German).

Beryllium is discussed with respect to production, mechanical properties, physical properties, corrosion, toxicity, and practical application in airplanes and rockets. In spite of high cost and difficulties in handling, beryllium brings very significant advantages in special situations. Within the temperature range from 150 to 200°C, large-scale beryllium application is not justified because fiber-reinforced plastics possess comparable properties and are much easier to handle. At higher temperatures, the special properties of beryllium cannot be matched by any of the common structural materials. (H.B.G.)

22097 SURFACE AND INTERFACIAL ENERGIES OF THE URANIUM–URANIUM CARBIDE SYSTEM. Hodkin, E. N.; Mortimer, D. A.; Nicholas, M. G.; Poole, D. M. (United Kingdom Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 39: 59-68(Apr 1971).

The surface and interfacial energies of the U–UC system were determined within the temperature range 850 to 1720°C from sessile drop experimental data and previously published data. The values obtained, in units of J/m^2, can be described as a function of temperature, t°C, by the following equations. Surface energy of UC, $\gamma_{UC-A} = (0.728 \pm 0.041) - 10^{-5}\,(t - 1325)$, $1325 \leq t \leq 1720$. Grain boundary energy of UC, $\gamma_{UC-UC} = (0.274 \pm 0.015) - 4 \times 10^{-6}\,(t - 1325)$, $1325 \leq t \leq 1720$. Interfacial energy between U and UC, $\gamma_{U-UC} = (0.141 \pm 0.008) - 7 \times 10^{-6}\,(t - 1100)$, $1100 \leq t \leq 1550$; $\gamma_{U-UC} = (0.141 \pm 0.008) - 6 \times 10^{-5}\,(t - 1100)$, $850 \leq t \leq 1100$. Surface energy of liquid U, $\gamma_{LU} = 1.45 \pm 0.012$, $1190 \leq t \leq 1600$. Surface energy of liquid U saturated with C, $\gamma_{LU(C)} = 1.44 - 2.35 \times 10^{-3}\,(t - 1325)$, $1325 \leq t \leq 1600$. (auth)

22098 THEORETICAL CONSIDERATIONS OF THE SUITABILITY OF VANADIUM ALLOYS AS CLADDING MATERIAL FOR (U,Pu) OXIDE FUELS. Schumacher, G.; Dorner, S. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 39: 69-76(Apr 1971). (In German).

The in-pile compatibility of oxide fuel with a metallic can depends on the thermodynamic equilibrium of the fuel material and the oxides of the cladding metal. The transfer of oxygen from the fuel to the can consisting of vanadium or a vanadium alloy was calculated using the mixed oxide of uranium and 15 mole % plutonium and the vanadium oxide. The influence of oxygen transport by thermal diffusion and CO/CO_2 equilibration in the fuel was taken into account. From the calculations it was found that a vanadium or vanadium alloy can was not compatible with a mixed oxide of uranium and plutonium even in a hypostoichiometric state. The oxygen concentration in the cladding material was a linear function of burnup. After 11% burnup it yielded about 16 at. % for a stoichiometric fuel and 8 at. % for a strongly hypostoichiometric fuel. A compatibility can be obtained by use of a cermet fuel containing a metallic component with a strong affinity to oxygen. (auth)

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22099 CARBIDE LAYER-GROWTH RATES ON TUNGSTEN–MOLYBDENUM AND TUNGSTEN–RHENIUM ALLOYS. Fries, R. J.; Cummings, J. E.; Hoffman, C. G.; Daily, S. A. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater.; 39: 35-48(Apr 1971).

The effect of alloying tungsten with rhenium (up to 25 at. %) or molybdenum (up to 32 at. %) on the structures and rates-of-growth of the carbide layers grown on these alloys was evaluated. A single carbide layer was observed on the tungsten–molybdenum alloys, consisting of (W, Mo)$_2$C with a few small isolated precipitate islands of the (W, Mo)C phase along the graphite edge of the M$_6$C layer. In contrast, layers of both (W, Re)C and (W, Re)$_2$C were observed to grow simultaneously on the tungsten–rhenium alloys, with a pearlite-like precipitate of a second phase present in the (W, Re)$_2$C layer along the carbide-metal interface. The existence of the cubic (β-manganese structure) π-phase was confirmed, and its homogeneity range was found to extend from at least W_3Re_4C to W_4Re_3C. The total carbide-layer growth rate was increased by the addition of either rhenium or molybdenum to the tungsten, with the rhenium effecting a larger increase than the same atom fraction of molybdenum. For both alloy types, the activation energy and the pre-exponential factor in the Arrhenius equation describing the layer-growth process decreased with increasing additions of the alloying atom. (auth)

Structure and Phase Studies

22100 (ANL-EBR-32) TRANSFORMATION KINETICS OF U-5 WT PERCENT Fs DRIVER-FUEL PINS PRODUCED BY AEROJET GENERAL CORPORATION. Chakraborty, A. K. (Argonne National Lab., Idaho Falls, Idaho). Nov 1970. Contract W-31-109-eng-38. 38p. Dep. NTIS.

The U–5 wt % Fs fuel pins in driver elements shortened during irradiation. Cause of the shortening was stresses on the fuel during the centrifugal bonding, which led to a texture responsible for the axial shortening. This unwanted texture, however, could be removed by subsequent heat-treating; this procedure is being used to salvage the centrifugally bonded fuel. To help determine the most effective annealing cycle, the transformation kinetics of as-cast and of as-bonded pins were studied by relating annealing time to hardness, density, electrical resistivity, microstructure, and diffraction patterns of the fuel. The results showed that: as-cast fuel would be transformed to the $\alpha + \delta + U_2Ru$ phases by annealing 40 min at 500°C; as-bonded fuel would be transformed to the $\gamma + U_2Ru$ phases by annealing 30 min at 660°C; as-bonded fuel heat-treated at 660°C for 2 hr would be transformed to the $\alpha + \delta + U_2Ru$ phases by annealing 40 min at 500°C. (auth)

22101 (UCRL-20330) STUDY OF NICKEL–TUNGSTEN ALLOY (Ni_4W) WITH FIELD-ION-FIELD-EMISSION MICROSCOPY. Lira-Olivares, Joaquin (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1970. Contract W-7405-eng-48. 60p. Dep. NTIS.

Thesis.

Field ion micrographs of pure metals and alloys usually show regions of different brightness. Some of these features were satisfactorily explained. However, agreement is lacking as to the origin of dark bands as they appear in nickel and some of its alloys. The existence of dark bands is substantiated and the conditions necessary for their appearance in FIM images clarified. Field ionization micrographs of Ni_4W as quenched from 1300°C showed a dark zone pattern at 78°K that was similar to the patterns obtained for Ni and Ni_4Mo. A less conspicuous pattern was observed in the β phase of the same alloy at 4.2°K. The dark band pattern was explained using a topographic model including preferential field evaporation at dark band regions of the specimen due to a higher work function at these regions. The use of field emission microscopy in conjunction with field ion microscopy proved effective in making it possible to discard some of the previous hypotheses and in relating work function to dark band formation. (auth)

22102 PRECIPITATION PROCESSES IN Ni-RICH Ni–Ta BINARY ALLOYS. Larson, Jay Michael. Seattle; Univ. of Washington (1970). 209p. University Microfilms Order No. 71-991.

A new phase identified as ordered Ni_8Ta was discovered in aged metastable Ni-rich Ni–Ta binary alloys containing from 8.3 to 13.7 atomic percent Ta. The structure of this phase and its effects on the mechanical properties of the Ni–Ta binary alloys were investigated. The Ni_8Ta phase was identified by means of electron and x-ray diffraction analyses as having a face centered tetragonal Ni_8Nb structure. During the aging treatment of a quenched Ni_8Ta alloy, electrical resistivity results indicated that the ordered Ni_8Ta phase precipitated from the disordered solid solution by an ordering reaction below the critical temperature of 568°C. Electron microscopy results showed that the ordered Ni_8Ta phase formed from the parent disordered Ni_8Ta phase by a nucleation and growth process. The density of the Ni_8Ta nuclei decreased with increasing aging temperature. The growth rate of the interface of the ordered Ni_8Ta domains into the disorder matrix was found to be consistent as a function of time and exhibited C-curve behavior as a function of temperature. Electrical resistivity results showed that the rate of formation of the ordered Ni_8Ta phase with respect to the aging time increased with increasing quench rate. Electron microscopy and electrical resistivity results indicated that plastic deformation of the quenched Ni–Ta binary alloys prior to aging impeded the homogeneous nucleation of the ordered Ni_8Ta phase, but increased the heterogeneous nucleation of the ordered Ni_8Ta phase during the aging treatment. A maximum in the rate of formation of ordered Ni_8Ta phase as a function of solute concentration occurred for an alloy that was slightly below the stoichiometric Ni_8Ta composition. Electron microscopy studies showed that the equilibrium Ni_3Ta phase with a beta Cu_3Ti structure was forming at incoherent boundaries at the expense of the Ni_8Ta ordered phase after aging the ordered Ni_8Ta phase slightly below the critical temperature for over 1000 hours. The superdislocation configurations in the ordered Ni_8Ta phase were unique compared to those observed in other ordered alloys in that they were composed of three a/2 ⟨110⟩ Burgers vectors in either a symmetric or an asymmetric configuration. The distance between the dislocations in the triple configuration allowed the antiphase boundary (APB) energies to be estimated. Using the geometry of the ordered Ni_8Ta structure, these APB energies were related to the atomic interactions between nearest neighbor shells around the APB's. The ductility, the strain hardening rate, and the proof stress were affected considerably by the presence of the ordered Ni_8Ta in the Ni–Ta alloys. These changes were described to changes in the dislocation structure and dislocation interactions. (Diss. Abstr. Int., B)

22103 DIFFUSE DIFFRACTION OF X-RAYS BY A SOLID SOLUTION. Strelova, S. V.; Umansky, Ya. S. Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 9, 125-8(1969). (In Russian).

A study was made of the diffuse diffraction of x-rays by U–30 at. % Mo solid solution. The deformed and oxidized surface layers of specimens were removed by electropolishing in 200 ml CH_3COOH–50 ml $HClO_4$. Diffraction was measured by a spectrometer employing monochromatized Cu–Kα radiation. Graphically presented experimental results and the calculated Laue curve are discussed. A theoretical account is given of the contributions of Compton and double Bragg diffraction to the total diffraction. These are shown to have relatively small values. (Metals Abstr.)

22104 X-RAY STUDY OF THE DEBYE–WALLER FACTOR OF Nb_3Sn. Vieland, L. J. (RCA Labs., Princeton, N. J.). Phys. Rev., B; 3: 1804-7(15 Mar 1971).

The Debye–Waller (DW) factors for Nb and Sn atoms in the intermetallic compound Nb_3Sn were determined by x-ray intensity measurements on a single crystal. The results are found to be in satisfactory agreement with the theory for both the angular and temperature dependence of the scattering. The data can be fitted by assigning Debye temperatures of 318 and 262°K to the Nb and Sn atoms, respectively. The anomalously large value of the DW factor found in a Moessbauer-effect study could not be confirmed. (auth)

22105 PRECIPITATES IN HIGH-CARBON CHROMIUM STEEL. Diergarten, Hans; Moehler, Karl Heinz; Weigel, Ludwig. Arch. Eisenhuettenw.; 41: 179-84(Feb 1970). (In German).

Thin films of steel containing C ~ 1.45 and Cr ~ 1.4%, hardened and tempered at 40 to 100°C were examined by x-rays and irradiated in the electron microscope for up to 10,000 min and C and carbides formed were detected. The ϵ-carbide Fe_2C and percarbide $Fe_{20}C_9$ were found and their crystallographic orientations measured. Diffuse rings appeared which were always absent from the untempered martensitic specimens. The scheme martensite → C in lattice imperfections → ϵ-carbide → percarbide → cementite was postulated. Further studies would be needed to detect any other intermediate phases. (Metals Abstr.)

22106 FORMATION OF FIBER TEXTURES IN POLYCRYSTALLINE ZIRCONIUM. Flade, Tilo; Huebner, Wolfgang; Tobisch, Joachim (Technische Univ., Dresden). Z. Metallk.; 62: 139-42 (Feb 1971). (In German).

Cold swaging and cold drawing through a die produced a (0002) ⟨10$\bar{1}$0⟩ deformation texture in zirconium with an oxygen content of less than 160 ppM. In the range of primary recrystallization a transition from the (0002) ⟨10$\bar{1}$0⟩ deformation texture to the (0002) ⟨11$\bar{2}$0⟩ recrystallization texture was observed. This recrystallization texture was fully developed only at the beginning of secondary recrystallization. The intermediate textures are simple fiber

textures. The (0002) $\langle 10\bar{1}0 \rangle$ deformation texture was found again after a free tensile test. In this case a part of the final orientation of recrystallization is conserved so that double fiber textures may occur. (auth)

22107 TOTAL MATERIAL VARIABLES INFLUENCING A DUCTILE-BRITTLE TRANSITION TEMPERATURE FOR MOLYBDENUM. Pink, E.; Armstrong, R. W. (Univ. of Maryland, College Park). Z. Metallk.; 62: 147-51(Feb 1971).

The ductile-brittle transition temperature for a coarse grained recrystallized molybdenum material was found to be lower than for the original fine grained metal from which it was produced. The coarse grain size resulted from a critical straining and subsequent annealing treatment at a low recrystallization temperature. It is concluded from an analysis of various strength parameters which are either measured or estimated for this material that an improved grain boundary strength and a considerable influence of the dislocation substructure are responsible for the less brittle behavior of the coarse grained molybdenum. (auth)

22108 MECHANICAL PROPERTIES OF COMPOSITE COPPER/NIOBIUM WIRE. Golovin, V. N.; Pletenetskii, G. E.; Somov, A. I.; Cherny, O. V. Probl. Prochnosti; No. 4, 100-1 (Apr 1970). (In Russian).

The method of Koch et al. was employed for the repeated drawing of a composite consisting of Nb strands in a Cu matrix. Good bonding between the materials was achieved with an intermediate anneal at 950°K for 30 min. After a final vacuum anneal for 30 min at 723°K the material was tested over the range 300 to 1000°K. The ultimate tensile strength on extension was 1.5–2 × that for Cu wire. The electrical resistivity of the composite, 1.80 $\mu\Omega$ cm, was only slightly more than that for Cu, 1.66 $\mu\Omega$ cm. (Metals Abstr.)

22109 ELECTRON-MICROSCOPE OBSERVATION ON ZIRCALOY-2. Okada, Takeshi (Kobe Steel, Ltd., Japan); Komatsu, Yukihiko. Kobe Seiko Giho; 20: No. 2, 30-4(Apr 1970). (In Japanese).

The microscopic behavior of hydride and the change in transition structure of Zircaloy-2 were observed with an electron microscope. The test specimen was 0.5 mm thick, cold-rolled; it was annealed at 750°C in vacuum. Subsequently, after annealing it was subjected to cold work and heat treatment. In quenching from 750°C, the hydride was observed as needle precipitates in $\langle 11\bar{2}0 \rangle$ direction on the (0002) plane at 60° angles to each other. When subjected to a strain, the hydride was oriented in a certain direction, which was not changed by heating to the recovery temperature. The hydride precipitated preferentially in transition lines and grain boundaries; but it also precipitated in the grains. In applying 0.2% strain, a transition elongated in one direction, corresponding to the principle gliding plane, was observed. In the case of 2% strain, the phase transformation occurred along the two gliding systems. (Japan)

22110 CRYSTALLOGRAPHIC TEXTURE AND HYDRIDE ORIENTATION IN ZIRCALOY CLADDING TUBES. Nagai, Nobuyuki; Kakuma, Tutomu (Kobe Steel, Ltd., Japan). Kobe Seiko Giho; 20: No. 2, 21-9(Apr 1970). (In Japanese).

The influence of fabrication conditions upon the crystallographic texture and hydride orientation in Zircaloy tubes was studied. The control of texture is important in the production of high-quality Zircaloy cladding tubes. As hydride orientation has influence upon the ductility of Zircaloy tubes, many qualitative investigations were done on hydride orientation. As a result of the present tests it was possible to specify production methods giving desirable Zircaloy tubes. (Japan)

22111 X-RAY INVESTIGATION OF THE SYSTEMS SCANDIUM–IRON–ALUMINUM AND CALCIUM–IRON–ALUMINUM. Zarechnyuk, O. S.; Vivchar, O. I.; Ryabov, V. R. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 10, 943-5 (Oct 1970). (In Ukrainian).

By means of x-ray analysis the ternary systems Sc–Fe–Al and Ca–Fe–Al were investigated in the range of 33.3 at. % of scandium or calcium; the isothermal sections (at 500°) were plotted. In the system Sc–Fe–Al two ternary compounds were found: $ScFe_{4.0 \to 7.1}Al_{8.0 \to 4.9}$ (phase ψ, tetragonal structure $ThMn_{12}$-type, a = 8.70 to 8.68, c = 4.81 to 4.77 Å) and $ScFe_{0.30 \to 1.35}Al_{1.70 \to 0.65}$ (phase λ_1, hexagonal structure $MgZn_2$-type, a = 5.301 to 5.108, c = 8.587 to 8.319 Å). In the system Ca–Fe–Al one ternary compound was found: $CaFe_4Al_8$ (phase ψ, structure $ThMn_{12}$-type, a = 8.85, c = 4.89 Å). (auth)

22112 PHASE DIAGRAM OF THE SYSTEM NEODYMIUM–BISMUTH. Kobzenko, G. F.; Chornogorenko, V. B. (Inst. of Problems of Materials, Kiev. Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 10, 945-8(Oct 1970). (In Ukrainian).

Alloys prepared in the arc furnace were investigated by the methods of thermal x-ray crystal and metallographic analyses and the phase equilibrium diagram of the system neodymium–bismuth was plotted. Solutions of bismuth and neodymium and four chemical compounds, Nd_3Bi, Nd_4Bi_3, NdBi, $NdBi_2$, were phase components of the alloys. The alloys may undergo six non-variant transformations depending on the composition. (auth)

22113 DISLOCATION LOOPS IN THE SURFACE LAYER OF CADMIUM CRYSTALS. Nishikawa, Hironobu (Nagoya Inst. of Tech., Japan). Jap. J. Appl. Phys.; 10: 276(Feb 1971).

Dislocation loops in the surface layer of monocrystalline cadmium were observed by progressively etching deeper these crystals with an etchant of water, ammonium hydroxide, and ammonium nitrate. (G.M.C.)

22114 INTERACTIONS BETWEEN SLIP DISLOCATIONS AND TWINS IN α-URANIUM. I. GEOMETRICAL AND ENERGETICAL CONSIDERATIONS. Saxl, I. (Nuclear Research Inst., Rez, Czech.). Czech. J. Phys.; 20: 1081-92(1970).

The geometrical conditions for the propagation of dislocations through the twins are applied to the main slip and twinning systems in α-uranium. The energy of dislocations moving through a twin was calculated using the isotropic elasticity. It was shown that the principal slip system with the Burgers vector [100] could easily propagate only through the $\{130\}$ compound twins. The possibility of uncommon slip systems in twins crossed by slip bands is discussed. (auth)

22115 KINETICS OF VOID GROWTH IN IRRADIATED METALS. Sears, V. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 39: 18-26(Apr 1971).

A theory is developed for the size distribution of voids produced in metals by fast-neutron irradiation. It is shown that observed size distributions can be interpreted directly in terms of the nucleation rate and the equivalent vacancy concentration. The method is applied in an analysis of void-size distributions in aluminum obtained recently by Packan and Braski. (auth)

Radiation Effects

Refer also to abstracts 21232, 21242, 22208, 22592, 22601, 23104, 23277, and 23310.

22116 (AEC-tr-7188) EFFECTS OF INITIAL HEAT TREATMENT ON THE MECHANICAL PROPERTIES OF HIGH NICKEL ALLOYS AFTER NEUTRON IRRADIATION. Votinov, S. N.; Balashov, V. D.; Grinchuk, P. P.; Masluk, V. M.; Ostrovski, E. E.; Prochorov, V. I.; Shamardin, V. K. Translation of Russian report. 22p. Dep. NTIS.

The effects of initial heat treatment on high-temperature embrittlement after irradiation were investigated on nickel alloys. It was shown that the states characterized by continuous precipitate walls along the boundaries and by the presence of the γ phase precipitates inside the grains embrittle to a great extent after irradiation. (auth)

22117 (BMI-1896, Sect.B) STUDIES OF THE EFFECTS OF IRRADIATION ON CLADDING AND STRUCTURAL ALLOYS. (Battelle Memorial Inst., Columbus, Ohio). 8p.

In Progress on LMFBR cladding, structural, and component materials studies during October–December 1970.

Stainless steel specimens irradiated in the EBR-II, to be tested to provide data for correlation with irradiation effects determined for specimens irradiated in the ETR, have been returned to the Battelle-Columbus Hot-Cell Facility. Creep tests at 650°C of Type 316 stainless steel, shock hardened by means of a flyer plate, show a continuous decrease in minimum creep rate with increase in shocking pressure. As observed with tensile property changes, contact explosive shocking achieves greater strengthening than does shocking by means of a flyer plate for equivalent calculated shocking pressures. Additional creep-rupture data have been obtained on low-carbon ferritic 2¼ Cr–1 Mo steel specimens during the report period. (auth)

22118 (SRARI-P-80) EFFECT OF INITIAL HEAT-TREATMENT ON THE MECHANICAL PROPERTIES OF HIGH-NICKEL ALLOYS AFTER NEUTRON IRRADIATION. Votinov, S. N.; Masl'uk, V. M.; Balashov, V. D.; Ostrovski, E. E.; Shamardin, V. K.; Grinchuk, P. P.; Prochorov, V. I. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1970. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effects of initial heat treatment on high-temperature embrittlement after irradiation were investigated on nickel alloys such as XH78T10P, X20H78T, and XH60B. It is shown that the states characterized by continuous precipitate walls along the

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boundaries and by the presence of γ^1-phase precipitates inside the grains embrittle to a great extent after irradiation. (auth)

22119 (WHAN-FR-40-1) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August–October 1970. Claudson, T. T. (ed.) (Hanford Engineering Development Lab., Richland, Wash.). Jan 1971. Contract AT-(45-1)-2170. 380p. Dep. NTIS.

Progress on materials research conducted at Argonne National Laboratory, Battelle Memorial Institute, Idaho Nuclear Corporation, Naval Research Laboratory, and Hanford Engineering Laboratory is summarized. Program coordination activities involving these organizations are also reported. (J.R.D.)

22120 LENGTH CHANGES IN α-PLUTONIUM DURING SELF-IRRADIATION DAMAGE BELOW 4.2K. Marples, J. A. C.; Mortimer, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett.; 34A: 242-3(8 Mar 1971).

The initial rate of change of length due to self-irradiation damage of α-Pu held both at and below 4.2°K was measured as 3.64×10^{-6} hr^{-1}. No indication of annealing in this temperature range was found. (auth)

22121 INVESTIGATION OF FAST-NEUTRON RADIATION DAMAGE IN AN AUSTENITIC STAINLESS STEEL. Bloom, Everett E. Knoxville, Tenn.; Univ. of Tennessee (1970). 183p. University Microfilms Order No. 71-332.

Thesis.

The nature of irradiation damage in Type 304 stainless steel was deduced from a study of microstructure and density of specimens irradiated by neutrons in the temperature range 370 to 800°C to fluences of 1×10^{18} to 5×10^{22} neutrons/cm^2 (E > 0.1 MeV). No damage was detected at exposures less than 1×10^{18} neutrons/cm^2 (E > 0.1 MeV). At 1.4×10^{20} neutrons/cm^2 (E > 0.1 MeV), small defect clusters, which appeared as black dots under suitable diffraction conditions, were present in the microstructure. Most of these small defect clusters were dislocation loops with Burgers' vectors of the type a/3 ⟨111⟩. A small fraction of the dots exhibited diffraction contrast consistent with either that expected from a/2 ⟨110⟩ dislocation loops or from defect clusters having spherically symmetric strain fields. The concentration of the small defect clusters decreased as the irradiation temperature was increased above 370°C. After irradiation at 524°C, no defect clusters were observed by transmission electron microscopy, indicating the concentration to be less than about 10^{12} defects/cm^3. Specimens irradiated to fast neutron fluences in the range 2×10^{21} to 5×10^{22} neutrons/cm^2 (E > 0.1 MeV) at 370 to 470°C contained voids and faulted interstitial dislocation loops. After irradiation to the lower fluences in this range the damage was heterogeneously distributed. Dislocation loops were clustered around dislocation lines and voids were located on dislocation lines. The void concentrations were higher at 370 to 380°C than at 460 to 470°C over the entire range of fluence investigated. The void concentrations increased as the fluence raised to the 0.66 and 1.66 power at 370 to 380°C and 460 to 470°C, respectively. After irradiation at 570 to 630°C, the damage structure consisted of a dislocation network, a few unfaulted dislocation loops, and voids nearly always associated with the dislocation lines. The only damage observed after irradiation at 770 to 840°C was helium bubbles which were present both at grain boundaries and within the matrix. A given void was found to grow rapidly early in its life. A short time after its formation the void growth rate decreased sharply. As a result, the density change was closely related to the void nucleation rate. The microstructures of specimens which contained cyclotron injected helium prior to their irradiation showed helium to have a pronounced influence on void formation. Specimens preinjected with helium contained a higher concentration of smaller voids. These observations are consistent with the concept that void nucleation occurs by the stabilization of void nuclei by the helium produced by (n,α) reactions. At low fluences and thus low helium concentrations, helium collects on dislocations and the first voids appear at these defects. As the helium concentration increases, stable nuclei form in the matrix and give a more uniform void distribution. Helium stabilization of void nuclei gives a void nucleation rate which is initially low, then increases until saturation of the void concentration occurs. The decrease in void growth rate is thought to be due to the buildup of a shell around the void within which the vacancy diffusivity is lower than in the homogeneous alloy. (Diss. Abstr. Int., B)

22122 CRITICAL ASPECTS OF NEUTRON IRRADIATION EMBRITTLEMENT OF PRESSURE VESSEL STEELS AND WELDMENTS. Steele, Lendell E. (Naval Research Lab., Washington, D. C.). Nucl. Met., Met. Soc. AIME; 16: 270-91(1970).

From Symposium on the Technology of Pressure-Retaining Steel Components, Vail Village, Colo. See CONF-700935.

The major aspects of neutron irradiation embrittlement in steel pressure vessels of large commercial nuclear power reactors are reviewed drawing on the results of AEC-sponsored programs which have emphasized research related to reactor vessel reliability. Since neutron radiation may harden and embrittle steels, periodic assessment of the operating reactor vessel ductility is necessary for assuring containment reliability. Embrittlement varies greatly depending on factors including especially the materials, temperature, and neutron environment. Steel variability has been demonstrated to be controllable through limitations on residual element content which can yield high resistance to radiation embrittlement. Similarly, welds have been produced with high embrittlement resistance. The trend of higher temperatures in more recently produced commercial water reactors is also a positive factor as neutron embrittlement is reduced at elevated temperatures. Other variable factors related to the nuclear and physical environment must be considered also. For the neutron energy spectrum, which varies considerably within a nuclear plant, knowledge is available to permit projection of the damaging potential of a specific neutron spectrum. Applying knowledge of the several critical factors affecting radiation embrittlement, a preventive approach for minimizing embrittlement has a firm basis for future vessels. For those now in operation or soon to be placed into operation, however, it is necessary that the knowledge of these critical factors be combined with advanced fracture safety approaches in order to maximize the potential for continued vessel reliability in nuclear service. (auth)

22123 VOID PRODUCTION IN STAINLESS STEEL DUE TO FAST NEUTRON IRRADIATION. Cawthorne, C.; Fulton, E. J. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). pp 377-85 of Physical and Fabrication Metallurgy. /Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970).

From 9th Commonwealth Mining and Metallurgical Congress, London, England. See CONF-690561-(Vol.4).

Stainless steel cladding from experimental fuel pins irradiated in the Dounreay Fast Reactor in the temperature range 230 to 650°C was studied by the use of thin-foil electron transmission techniques. The examination reveals, in addition to the damage normally associated with atomic displacement effects, a copious production of voids. The formation of these voids is attributed to a vacancy condensation process occurring, to its maximum extent, at temperatures of about 450 to 500°C. (auth) (UK)

22124 EFFECTS OF PROTON BOMBARDMENT ON ELECTRIC RESISTANCE OF THIN FILMS OF SILVER. Chechetenko, V. V.; Tishchenko, L. P.; Fogel, Ya. M. (Physical-Technical Inst. of Low Temperatures, Kharkov. Kharkov State Univ.). pp 43-52 of Fizika Metallicheskikh Plenok. /Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1969). (In Russian).

The formation of defects in thin films of Ag during bombardment by protons at 10 to 40 kV was investigated. A formula is included which relates the formation and annealing of defects with film conductivity, irradiation time, and disappearance of defects after cessation of irradiation. It is concluded that Brinnel-type defects and defects due to hydrogen atoms occur in proton bombardment of the film. An equation which describes the annihilation of the paired defects is noted. The activation energy for annihilation of paired defects was found to be temperature dependent. (tr-auth)

22125 THEORY OF THE EFFECT OF IRRADIATION ON THE CREEP OF METALS. Ovander, L. N. At. Energ. (USSR); 29: 381(Nov 1970). (In Russian).

In view of the exposure of reactor components to elevated temperatures and pressures while being irradiated, the creep rate is of great importance for the designer. Passage of the neutron flux through the crystal lattice creates defects, such as dislocation loops and vacancies which affect the plastic flow of the crystal. It was assumed that the pressure was sufficiently high to shift the dislocations; this shift is stopped by barriers such as static dislocations formed during deformation. The deformation rate was calculated from the concentration of vacancies, derived from the chemical potential. The increase of radiation-induced dislocations may be attributed to the increase of the number of sources. The increase of creep in the model proposed by J. Weertman should be related to the increase of the number of dislocations and not to supersaturation of vacancies. (TTT)

22126 TECHNIQUE OF CORROSION AND ELECTROCHEMICAL INVESTIGATIONS IN THE REACTOR UNDER IRRADIATION. Krast, Kh. B.; Byalobzheskii, A. V.; Lepin, L. K.; Kadek, V. M. (Inst. of Inorganic Chemistry, Riga). Latv. PSR Zinat. Akad. Vestis; No. 12, 110-14(1970). (In Russian).

Experimental studies on corrosion and electrochemistry carried out in the IRT-2000 reactor using aluminum in aqueous solutions are described. (R.V.J.)

22127 RADIATION DAMAGE STUDIES USING THE LOW TEMPERATURE IRRADIATION FACILITY. IV. MEASUREMENT OF X-RAY SMALL ANGLE SCATTERING OF Al ALLOYS. Kawano, Osamu; Liu, Kuo Shun; Yoshida, Hiroyuki (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 209-10(1970).

The effects of neutron irradiation on the structure of spherical Guinier–Preston (G.P.) zones and intermediate precipitates in aluminum alloys were studied by x-ray small angle scattering. It was shown that the average G.P. zone radius or intermediate precipitates after irradiation was smaller than before irradiation, and the size distribution of particles in the irradiated specimen was always wider and the integral intensity was larger compared with those before irradiation. The results suggested that G.P. zones and intermediate precipitates are partially broken up and dissolved in the matrix by the displacement and thermal spikes. (R.C.K.)

22128 RADIATION DAMAGE STUDIES USING THE LOW TEMPERATURE IRRADIATION FACILITY. III. MEASUREMENT OF INTERNAL FRICTION OF Fe–B ALLOYS. Kitajima, Kazunori; Koiwa, Masahiro; Futagami, Koji; Yoshida, Hiroyuki (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 205-8(1970).

Internal friction measurements were made of specimens of B–Fe and B–Fe–Nb alloys. The measurements were made on B–Fe alloys inside the loop and on B–Fe–Nb alloys outside the loop. Results of measurements are presented in tables and graphs. (R.C.K.)

22129 RECOVERY STAGES OF NEUTRON IRRADIATED NIOBIUM, ZIRCONIUM, AND THEIR ALLOYS. Yoshida, Hiroyuki; Kodaka, Hisao (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 187-90(1970).

The thermal recovery of neutron irradiated and plastically deformed specimens of niobium, zirconium, and their alloys was studied by measuring changes in electric resistivity in order to obtain a basic understanding of their irradiation behavior. The materials used in the preparation of the specimens were reactor-grade zirconium reduced by magnesium, and niobium purified by electron beam melting from 99.8% pure powder. Prior to neutron irradiation and cold work, the specimens were annealed for 1 hr at 1000°C in high vacuum and then quenched in water. Neutron irradiation was performed in the core of the Kyota University Research Reactor. Changes in the electric resistivities during isochronal annealing are given for the cold worked and the irradiated pure zirconium, and the irradiated niobium-zirconium alloys. The cold worked zirconium gradually recovered with increasing of annealing temperatures and an activation energy of about 1.5 eV. Two stages of recovery were observed for the irradiated zirconium. One stage occurred at around 160°C and had an activation energy of about 1.3 eV. For the irradiated niobium-zirconium alloys the electric resistivity decreased with increasing annealing temperatures. The stage of both specimens which occurred at about 160°C seemed to correspond to the recovery of the radioinduced defects. (R.C.K.)

22130 EFFECTS OF NEUTRON IRRADIATION ON AGEING AND PRECIPITATION PHENOMENA IN AN ALUMINUM–2.8 AT PERCENT ZINC–1.4 AT. PERCENT MAGNESIUM ALLOY. Murakami, Yotaro; Kawano, Osamu; Yoshida, Hiroyuki (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 3: 139-46(1970).

The irradiation effects on Guinier–Preston (G. P.) zone formation and precipitation of η' phase in an aluminum-2.8 at. % zinc-1.4 at. % magnesium alloy were investigated by means of electrical resistivity measurement, micro-Vickers hardness test, measurement of x-ray small angle scattering, and transmission electron microscopic observation. When the supersaturated specimens were irradiated at the dose of 4×10^{17} fast neutrons/cm^2 at the reactor ambient temperature, electrical resistivity and particle volume fraction were increased by G. P. zones formed during irradiation. It was found that G. P. zones were partially reverted for an initial period of post-irradiation ageing at 180 and 220°C, and then more stable zones grew and acted as nuclei for η' precipitates. When G. P. zones and η' precipitates were already formed before irradiation, increment of volume fraction and decrement of particle size by irradiation were observed. These facts were discussed with the results of electron microscopic observation. (auth)

22131 ANISOTROPIC IRRADIATION GROWTH OF EBR-II DRIVER FUEL PINS. Walter, C. M. (Argonne National Lab., Idaho Falls, Idaho); Chakraborty, A. K.; Bacca, J. P.; Shewmon, P. G. J. Nucl. Mater.; 39: 122-4(Apr 1971).

The effect of axial compressive stress on the irradiation growth of EBR-II fuel pins of uranium-5 wt % fissium alloy and the influence of irradiation temperature on this growth were studied. The fuel pins from 3 of 6 centrifugally bonded vendor-fuel elements were removed from their jackets, inverted, and placed in the inverted position in 3 new jackets. All 6 elements were impact bonded, positioned adjacent to each other, and irradiated to about 0.35 at. % burnup. The experimental results clearly showed that anisotropic irradiation growth increased with increasing compressive stress and indicated that the growth due to texture decreased significantly with increasing irradiation temperature. (G.M.C.)

22132 RELATIONSHIP OF MICROSTRUCTURE TO EMBRITTLEMENT IN IRRADIATED STAINLESS STEEL AT ELEVATED TEMPERATURES. Kangilaski, M.; Zurey, F. T.; Perrin, J. S.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio). J. Nucl. Mater.; 39: 117-21(Apr 1971).

Transmission electron microscopy (TEM) studies were performed to characterize the structure of Type 347 stainless steel which was irradiated to a fast fluence of 2.1×10^{22} n/cm^2 at 50°C in ETR. The stainless steel was in solution annealed condition with the grain size being 12 μm. These specimens were tested in tension in either the as-irradiated condition or after annealing 1 hr at 980°C following irradiation. (auth)

22133 CONSIDERATIONS ON THE RELATION BETWEEN CREEP UNDER IRRADIATION AND THE DEFECTS PRODUCED BY IRRADIATION IN THE ABSENCE OF STRAIN. Martin, G.; Poirier, J. P. (CEN, Saclay, France). J. Nucl. Mater.; 39: 93-101(Apr 1971). (In French).

The migration to dislocations of vacancies or interstitials created during neutron irradiation brings about supplementary creep when one type of point defect is segregated in loops or voids. A balance-sheet of defects arriving at dislocations is set up, not by solving the diffusion equations but rather by taking account of the experimentally observed growth of interstitial loops and of voids in irradiated samples. Generalized Nabarro creep, caused by climb of a family of anisotropically distributed dislocations, is slowed down if climb takes place through vacancy absorption; the slowing down is proportional to the difference between the rate of swelling and the rate of assembly of interstitials into loops. In the case of Weertman creep where voids act as dispersed obstacles, one can predict the effect of irradiation if one knows the swelling kinetics and the distribution of voids and interstitial loops. (auth)

22134 CONTINUUM-MECHANICS AND MICRO-MECHANISMS FOR IN-REACTOR CREEP OF ZIRCONIUM ALLOYS. Holicky, M. J.; Schroeder, J. (Univ. of Waterloo, Ont.). J. Nucl. Mater.: 39: 27-34(Apr 1971).

A theoretical correlation of coefficients of anisotropy of the zirconium alloy continuum with known texture coefficients of zirconium alloys is proposed. This correlation leads to limits for magnitudes of the coefficients of anisotropy for zirconium alloys and by using these limits due to texture in connection with ranges established from continuum mechanics, bounds for magnitudes of these coefficients are estimated. Significant bounds are proposed for cold-worked Zircaloy-2 and cold-worked zirconium/2.5% niobium for stresses larger than 20,000 psi and 15,000 psi respectively. Comparing the ranges due to continuum mechanics with the limits based on texture, conclusions may be drawn whether or not in-reactor creep is texture-dependent. (auth)

Ceramics and Cermets

Corrosion and Erosion

Refer also to abstracts 21258, 22006, and 22007.

22135 (MDC G–2026) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 8, July–September 1970. Andelin, R. L.; Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Oct 1970. Contract AT(45-1)-2138. 26p. Dep. NTIS.

Conclusions reported previously for plutonia/refractory metal compatibility were reaffirmed by electron microprobe analysis. Exposure continues at 1800 and/or 2000°C on plutonia-238/refractory metal, curia-244/refractory metal, and plutonia-molybdenum cermets. Materials have been ordered for initiating a more systems-oriented test program using either plutonia-molybdenum cermets or plutonia solid-solution cermets in refractory metal containers. An analysis was made of the extent and effects of oxygen uptake in the Ta-10W liner and T-111 strength member for the Pioneer heat source over the temperature range from 800 to

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1000°C. Results obtained are strongly a function of the controlling oxygen transport mechanism. (auth)

Preparation and Fabrication

Refer also to abstracts 22044 and 22046.

22136 (BM-RI-7485) TUNGSTEN AND DISPERSION-STRENGTHENED TUNGSTEN MADE BY FREEZE DRYING. Ferrante, Michael J.; Lowery, R. R.; Robidart, G. B. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Mar 1971. 32p.

The applicability of the freeze-drying technique for preparing dispersion-strengthened tungsten powders suitable for conversion by powder metallurgy into materials which might have improved high-temperature strength was investigated. Extruded rods from compacts of tungsten-5 vol % thoria had at 1,650°C a tensile strength of 30,300 psi and a 10-hour stress-rupture strength of 12,700 psi. These are slightly below those measured for swaged rods of commercial tungsten-3.7 vol % thoria. Only those tungsten-thoria dispersions containing a stoichiometric deficiency of oxygen yielded a significant strengthening effect. A low-melting eutectic formed in extruded tungsten dispersions containing either zirconia or yttria, which caused a lowering of the tensile strengths. These tensile strengths were only slightly higher than strengths of elemental tungsten made from commercial powder having a particle size of 2.4 microns (Fisher subsieve). Sheet made from this commercial tungsten had a slightly higher tensile strength than tungsten made by freeze drying, but the freeze-dried tungsten sheet had a lower recrystallization temperature, a lower ductile-to-brittle transition temperature, and a higher purity. (auth)

22137 (NUMEC-3524-74) FABRICATION OF 20 w/o PuO_2–UO_2 FAST BREEDER FUELS FOR IRRADIATION TESTING IN EBR-II. (Nuclear Materials and Equipment Corp., Leechburg, Pa. Plutonium Lab.). Jun 1970. Contract AT(30-1)-3524. 67p. Dep. NTIS.

Work performed under Task 1 of the program as related to the fabrication and characterization of Series A, B, and C fuel rods for irradiation testing in EBR-II and the corresponding archive rods, designated as Series D is summarized. (J.R.D.)

22138 (WHAN-SA-14) PREPARATION OF IRRADIATED LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROTOTYPIC FUELS FOR METALLOGRAPHY. Gruber, W. J. (Hanford Engineering Development Lab., Richland, Wash.). [1969]. Contract AT(45-1)-2170. 16p. (CONF-701118-1). Dep. NTIS.

From 3rd Meeting of the international metallographic Society; Cleveland, Ohio (16 Nov 1970).

Irradiated, fast reactor, prototypic, mixed oxide, and cermet fuel components were sampled and prepared in remote facilities for metallographic examinations. Metallography, shielded electron microprobe studies, conventional and scanning electron microscopy from replicas, microsampling, and autoradiography were routinely employed to obtain post-irradiation data. Various sampling and preparation techniques were adapted or developed for these examinations. The selection and sequencing of preparation techniques are based on fuel type, examination requirements, and irradiation history. (auth)

22139 SINGLE CRYSTALS OF URANIUM OXIDES BY CHEMICAL TRANSPORT REACTIONS. Naito, Keiji; Kamegashira, Naoki; Nomura, Yuji (Nagoya Univ., Japan). J. Cryst. Growth; 8: 219-20(Feb 1971).

Single crystals of various uranium oxides such as UO_2, U_4O_9, and U_3O_8 were prepared by chemical transport reactions using halogen gases as transporting agents with a temperature gradient of 1000°C to 850°C in closed tubes. (auth)

22140 APPLICATIONS OF SINTERING IN NUCLEAR INDUSTRY. Accary, A. (CEN, Saclay, France). Powder Met. Int.; 2: No. 2, 40-2(Jun 1970).

The different applications of sintering to the fabrication of nuclear materials are reviewed. The following are considered: fuel materials, cladding materials, control materials, shielding materials, and irradiation sources. It was shown that for the production of many of these materials, sintering was the necessary method owing to their nature as ceramics or dispersion-strengthened materials. It appears that in cases when other methods were also available, sintering was the recommended one for the better property control of the end product and for economical considerations. In conclusion, it is also stressed that many fundamental and applied studies which were initiated aiming at nuclear applications improved our knowledge of sintering for the benefit of all other possible applications. (auth)

22141 PREPARATION AND IDENTIFICATION OF THE ZrS PHASE IN THE ZIRCONIUM–SULFUR SYSTEM. Steiger, Ronald P.; Cater, E. David (Univ. of Iowa, Iowa City). Contract AT(11-1)-1182. High Temp. Sci.; 2: 398-401(Dec 1970).

Zirconium monosulfide was prepared by high-temperature, high-vacuum techniques. The pure phase was identified by chemical and powder x-ray analyses. It had a fcc NaCl type structure with lattice parameter, a = 5.1522 ± 0.0005 Å. Solid solutions of ZrS and YS were prepared by vacuum annealing $ZrS_{1.6}$ with YS and Zr metal with YS. These solid solutions also exhibited a NaCl cubic structure. Mass spectrometric analysis of zirconium sulfide (over the range ZrS_{1+x} to ZrS_{1-x}) showed that the vapor species present at high temperatures were Zr^+, ZrO^+, ZrS^+, and S^+. Only a small amount of ZrO^+ was present and it disappeared after a short period of time. (auth)

22142 ELECTRODEPOSITION OF COHERENT COATINGS OF REFRACTORY METALS. VII. ZIRCONIUM DIBORIDE. Mellors, G. W.; Senderoff, S. (Union Carbide Corp., Parma, Ohio). J. Electrochem. Soc.; 118: 220-5(Feb 1971).

The electrodeposition of coherent coatings of zirconium diboride from a solution of ZrF_4 and B_2O_3 in the molten eutectic mixture of NaF–KF–LiF is described. A constant composition is maintained by using a ZrB_2 anode and composition such that no volatile BF_3 is formed. The function of B_2O_3 as an oxide ion getter in the solution is demonstrated. (auth)

22143 SINTERING AND MICROSTRUCTURE CONTROL. Burke, J. E. (General Electric Co., Schenectady, N. Y.). pp 413-41 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

Elementary facts and relations and quantitative theories concerning sintering are discussed. Factors that influence sintering times and temperatures and the structure of the final product are considered. Topics discussed include: neck formation between particles; quantitative model for shrinkage rate; sintering in uranium dioxide; particle size; initial and later stages of sintering; inhibition of boundary movement by second-phase inclusions; grain growth in ceramics; mobility of grain boundaries; liquid-phase sintering; and hot pressing. (G.M.C.)

22144 MINERALOGICAL STUDY ON ThO_2–UO_2 BINARY SYSTEM. Tanabe, Kazuya (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Third Ser.; 11: No. 1, 15-61(Mar 1970).

ThO_2 occurring in nature is called thorianite with the main composition of $(Th,U)O_2$; pure ThO_2 single crystals do not occur in nature. Furthermore, ThO_2 has the highest melting point (3220° ± 50°C) of all the oxides and is chemically stable so that single crystals are difficult to synthesize and reports of the synthesis of ThO_2 single crystals have been few. Two methods were used to synthesize ThO_2 single crystals. One was a melting method in which ThO_2 sintered bodies were melted by a plasma-jet or solar furnace. The other was a flux method using a PbF_2–NaF–B_2O_3 flux. ThO_2–UO_2 mixed crystals were synthesized with the flux mixture which was used in the synthesis of ThO_2 single crystals. The ratio of various ThO_2–UO_2 mole % mixtures was allotted according to the ratio of ThO_2 used in the synthesis of ThO_2 single crystals. These ThO_2–UO_2 mixed crystals thus obtained considerably deviated from the initial ratio of ThO_2/UO_2. Some physical properties (mainly optical and electric) and growth mechanism of the ThO_2 single crystals and ThO_2–UO_2 mixed crystals were also studied and discussed in some detail. (auth) (Japan)

22145 FORMATION OF U_2C_3 IN THE REACTION OF UC_2 WITH UO_2. Tagawa, H.; Fujii, K. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 39: 109-14(Apr 1971).

The formation of U_2C_3 by the reaction of UC_2 with UO_2 was studied by chemical and x-ray analyses at temperatures between 1400 and 1700°C in vacuo. The reaction is represented by $7\ UC_2 + UO_2 \rightarrow 4\ U_2C_3 + 2\ CO$. When the composition of the resulting carbides corresponds to hypostoichiometric U_2C_3, the product consists of U_2C_3 and UC; and, UC_2 disappears as the reaction terminates. When the composition corresponds to hyperstoichiometric U_2C_3, it consists of U_2C_3 and UC_2; UC is formed only as an intermediate compound. The lattice parameter of U_2C_3 is around 8.0891 Å. The lattice parameters of UC and UC_2 vary with the reaction time, and become finally the values for the pure compounds, respectively. Therefore, it is indicated that both the UC and UC_2 phases dissolve some quantities of oxygen in the course of reaction. (auth)

22146 INCORPORATION OF SOLID FISSION PRODUCTS IN SPHERICAL NUCLEAR FUEL MODEL PARTICLES BY A SOL-GEL METHOD. Hamesch, M.; Foerthmann, R.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). J. Nucl. Mater.; 39: 102-8(Apr 1971). (In German).

Out-of-pile experiments can yield important indications for the study of solid fission product transport processes in pyrolytic carbon-coated particle fuels. Particularly suitable for these experiments were model particles in which solid fission products were incorporated during the manufacturing process. A known sol-gel method was tried for this purpose. The fission products Sr, Ba, Y, Zr, Nb, and some rare earth elements were included in amounts from 1 to 2% of the atomic composition in spherical UO_2- and $(U,Th)O_2$-particles, simulating a 10% fima burnup. The doped model kernels were coated with pyrolytic carbon and characterized by chemical analysis, metallography, microsonde and determination of the lattice constants. (auth)

22147 PREPARATION OF URANIUM CARBIDE PELLETS IN A SIMPLIFIED PROCESS. Maruya, Kazuo; Komine, Isao (Mitsubishi Atomic Power Industries Inc., Omiya, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: 95-105(Feb 1971).

A study was made on the preparation of UC pellets from mixed powders of UO_2 and graphite in a dry process. The conditions of carbothermic reduction were determined. Pressing and sintering procedures using UC clinkers were studied. An examination was made on the effects of additives and of differences in carbon content on the densities obtainable on the product pellets. (auth)

Properties Evaluations

Refer also to abstracts 21246, 22088, 22090, 22092, 22097, 22098, 22633, 22638, 22644, and 22647.

22148 (BM-RI-7479) PROPERTIES OF CAST COLUMBIUM CARBIDE–CARBON ALLOYS. Asai, Gene; Paulson, D. L.; Kelly, Hal J. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Feb 1971. 68p.

Properties obtained for niobium carbide-carbon castings ranging in carbon content from 12 to 17 weight percent were compared with those of hot-pressed composites of similar composition. The properties were oxidation resistance in static air between 500 and 700°C, linear thermal expansion between 20 and 2,400°C, electrical resistivity between 20 and 1,500°C, microhardness between 20 and 1,500°C, and modulus of rupture between 1,300 and 1,800°C. NbC–C castings differed markedly from hot-pressed material with respect to microstructure, electrical resistivity, and modulus of rupture, but behaved quite similarly with respect to oxidation resistance, thermal expansion, and hot hardness. In oxidation resistance, thermal expansion, and hot hardness both materials were independent of carbon content. Both castings and hot-pressed composites oxidized rapidly in air above 600°C, had thermal expansion coefficients very similar to niobium metal, and the logarithm of the hardness decreased linearly with increasing temperature. The microstructures of hot-pressed composites contained varying amounts of graphite in a NbC matrix but did not contain significant amounts of a eutectic structure present in all castings, nor did they contain graphite needles which were present in the hypereutectic castings. The higher electrical resistivity of hypereutectic castings over hypereutectic hot pressings was attributed to the presence of highly oriented graphite needles in the castings. The modulus of rupture of castings was 1½ to 2 times that of hot-pressed composites. Both materials displayed bend ductility above 1,800°C. (auth)

22149 (BMI-1895) COMPATIBILITY OF NITRIDE REACTOR FUELS WITH AUSTENITIC STAINLESS STEELS. Hebeisen, John C.; Moak, Donald P.; Pfeifer, William H. (Battelle Memorial Inst., Columbus, Ohio). Jan 1971. Contract W-7405-eng-92. 32p. Dep. NTIS.

The compatibility of UN and (U,Pu)N fuels with austenitic stainless steel cladding under simulated liquid-metal fast-breeder-reactor (LMFBR) conditions was evaluated using compatibility couples heated in both sodium-bonded and pressure-contacted capsules for times from 1,000 to 10,000 hr at temperatures from 700 to 1000°C. Stoichiometric mononitride fuels were compatible with austenitic stainless steel claddings for at least 10,000 hr at 700°C and 1,000 hr at 1000°C. However, several factors had an adverse effect on the compatibility. Oxygen contained in the cladding or capsule environment readily reacted with the fuel to release nitrogen; the nitrogen so formed diffused into the claddings, with the formation of nitride precipitates. Nonstoichiometric fuels also reacted with the stainless steels. The free metal present in hypostoichiometric fuels initiated melting reactions in several capsules heated at 1000°C, and the sesquinitride phase present in hyperstoichiometric uranium nitride fuels decomposed to UN, with the formation of chromium nitride precipitates in the cladding. The rate of cladding nitridation in capsules containing hyperstoichiometric UN and a sodium bond was slight (<1 mil after 10,000 hr at 700°C), and was controlled by the release of nitrogen from the fuel; for UN fuels this is the diffusion rate of nitrogen through the mononitride phase. Hyperstoichiometric mixed nitride containing the oxide phase in intimate association with the sesquinitride did not react with stainless steel cladding in 10,000 hr at 700°C or 1,000 hr at 1000°C. This inert behavior is thought to be related to the stabilizing effect the oxide phase has on the sesquinitride. (auth)

22150 (LA-tr-71-13) ENTHALPY OF ACTIVATION OF CARBON SELF-DIFFUSION IN CUBIC CARBIDES. Oshcherin, B. N. Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from Fiz. Metal. Metalloved.; 29: 300-4(1970). 9p. Dep. NTIS.

The activation enthalpy of self-diffusion in crystals with an NaCl structure and the activation enthalpy of carbon self-diffusion in cubic carbides are considered from the concept that the activation enthalpy of diffusion is work against the forces causing the lattice strength, for the case of a vacancy diffusion mechanism. (auth)

22151 (LA-tr-71-14) SELF-DIFFUSION OF CARBON IN CARBIDES OF GROUP IV AND V TRANSITION METALS. Andrievskii, R. A.; Klimenko, V. V.; Khromov, Yu. F. Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from Fiz. Metal. Metalloved.; 28: 298-303(1969). 8p. Dep. NTIS.

The self-diffusion of carbon was studied by ^{14}C in hafnium, zirconium, niobium, and tantalum carbides at 2200 to 2800°C. Analysis of the experimental data showed that the effect of boundary diffusion is insignificant in this case. The self-diffusion parameters are compared with the physicochemical properties of carbides, and the correlations between the diffusion activation energy of carbon and the melting point, as well as the heat of formation of the carbides, are noted. The level of diffusion mobility in carbides in comparison with metals and carbon is discussed. (auth)

22152 (SC-DR-70-908) HUGONIOT RELATIONSHIP FOR A HIGH DENSITY, DISTENDED CERMET (THORIA-MOLYBDENUM). May, R. P. (Sandia Labs., Albuquerque, N. Mex.). Feb 1971. 19p. Dep. NTIS.

Hugoniot data are presented for the cermet to a material velocity of 0.262 mm/μsec. This resulted in a maximum stress of 110 kilobars. An elastic wave was measured at a velocity of 5.22 mm/μsec and nominal stress of 12 kilobars. The material studied was distended with an initial porosity of four percent. By using a theoretical solid density of 10.022 g/cm^3 and assuming that the solid was linearly elastic to the maximum stress of this study, it was found possible to fit the data to the porous ($p-\alpha$) model of Herrmann. (auth)

22153 (WAPD-TM-983) PORE MOTION IN SOLIDS RESULTING FROM APPLIED STRESSES (LWBR DEVELOPMENT PROGRAM). Leiden, S. H.; Trinko, M. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb 1971. Contract AT-11-1-GEN-14. 22p. Dep. NTIS.

Much interest has lately been centered on stress-induced pore migration within the fuel elements of atomic reactors. A computer oriented analysis was undertaken in an attempt to fix the sign and magnitude of the response of a pore to a stress field. The results agreed with other analytical results reported on the interaction of two bubbles within a solid continuum and that bubble-free surface and bubble-clamped surface interactions can be analyzed in a way similar to the bubble–bubble problem. It was verified that two bubbles will always attract as long as one contains some uncompensated pressure. Further, a bubble containing uncompensated pressure will be attracted to a free surface and repelled from a clamped surface. Finally, it is shown that a void placed in a linear uniaxial stress gradient will move up the gradient, no matter whether the gradient is produced by external tension or compression. Numerical estimates are made for the size of expected forces on real-sized bubbles. (auth)

22154 REACTIONS OF Sc_2O_3 WITH Nb AND Ta PENTOXIDES. Vladimirova, Z. A.; Trunov, V. K.; Kommissarova, L. N. (Moscow State Univ.). Zh. Neorg. Khim.; 15: 2862-5(Oct 1970). (In Russian).

X-ray phase analysis was made of the reactions of Sc_2O_3 with Nb and Ta pentoxides in a wide range of concentrations. The results showed that Nb compounds with scandium exhibited a lower thermal stability (about 300°C) as compared to the scandium tantalates. The melting point of all examined compounds was above 2000°C. (R.V.J.)

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22155 MECHANICAL PROPERTY AND INTERFACE REACTION STUDIES OF TITANIUM–ALUMINA COMPOSITES. Tressler, Richard E.; Moore, Terry L. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Metals Eng. Quart.; 11: No. 1, 16-22(Feb 1971).

Composites of Ti-6Al-4V–Al_2O_3 were fabricated by vacuum diffusion bonding at 1500°F and 14 ksi for 15 minutes. The bonding process was very sensitive to variations in interfilament spacing and foil thickness. On the basis of composite property degradation studies, longer bonding times or slightly higher temperatures would assure adequate bonding without compromising mechanical properties. At elevated temperatures commercially pure titanium and Ti-6Al-4V reacted with Al_2O_3 to form a complex reaction zone containing Ti_3Al as the principal phase and a much wider zone of embrittled titanium. The reaction rate was slightly higher for the alloy matrix but with essentially the same temperature dependence, $2Q = 50.3$ kcal/mole versus 51.5 kcal/mole for the pure matrix in an Arrhenius plot. The reaction rate constants at 1000°F were an order of magnitude greater than the corresponding values for titanium-boron composites, only slightly greater than the titanium-Borsic values, and one-third of the rate for titanium/SiC composites. However, the composites' properties appeared to be less sensitive to reaction than were titanium-boron and titanium-SiC. Longitudinal tensile strengths and elastic moduli of 20 to 25 vol % filament composites were slightly less than the rule-of-mixtures values (maximum UTS = 125,000 psi and $E = 27 \times 10^6$ psi). Corresponding transverse tests revealed interface fracture of poorly bonded specimens at 30,000 to 40,000 psi and filament fracture of well bonded specimens at 57,000 psi. Filament misalignment and lack of complete consolidation prevented achievement of mechanical properties characteristic of defect free material. Annealing studies of tensile specimens revealed no degradation in composite properties after 8 hr at 1500°F but observable degradation in properties after 69 hours at 1500°F due to filament degradation and matrix embrittlement by oxygen and aluminum liberated in the chemical reaction. (auth)

22156 WEAR BEHAVIOR OF CEMENTED CARBIDE ALLOYS UNDER DIFFERENT CONDITIONS OF MACHINING. Jung, Otto; Kohlhaas, Erich; Dawihl, Walther; Peter, Walter (Roechling'sche Eisen- und Stahlwerke GmbH, Voelklingen, Ger.). Arch. Eisenhuettenw.; 41: 1103-10(Nov 1970). (In German).

Turning, milling, and boring tests were carried out with cemented carbide alloys of different coercive force, as well as with tungsten carbide-cobalt alloys containing 6 to 20% Co. The turning or friction path was characterized as a quantity of assessing the mean wear of top face of the tools. (auth)

22157 TRIBOCHEMISTRY OF TUNGSTEN(VI) OXIDE. Albrecht, R.; Haeusler, H.; Moebius, R. (Technische Hochschule, Merseburg, Ger.). Z. Anorg. Allg. Chem.; 377: 310-15(1970). (In German).

When tungsten(VI) oxide was ground in a laboratory vibration mill, several alterations were observed. WO_3 was reduced to an oxide of the composition $WO_{2.98}$ as a limiting value. After grinding for one hour, α-β transformation took place. Enlargement of surface was observed only within a very short period of grinding. With increasing period of grinding WO_3 was completely converted to an amorphous state. DTA and EPR measurements indicated formation of radicals during grinding. (auth)

22158 EFFECT OF CERTAIN TECHNOLOGICAL FACTORS ON THE DEGREE OF VOLATILIZATION OF B_2O_3 IN THE MELTING OF NON-ALKALINE ALUMOBOROSILICATE GLASS FOR THE PRODUCTION OF FIBERGLASS. Kolesov, Yu. I.; Malashkina, T. G.; Platonov, R. I. (All-Union Scientific Research Inst. of Glass Plastics and Glass Fibers, Moscow). Steklo Keram.; No. 5, 19-22(May 1970). (In Russian).

The volatility of B_2O_3 was studied during melting of alumoborosilicate glass E in three types of vat ovens: regenerative, recuperative, and direct heat gas-electric oven. It was determined that maximum volatilization of 70 to 90% B_2O_3 was observed at the stage of the vitrification of the furnace charge. In the gas-electric oven the loss of B_2O_3 in the light zone was several-fold higher than in gas ovens. To lower the losses of B_2O_3 it is proposed that the period of glass formation be shortened by increasing the temperature at the point of the furnace charge loading and that boron anhydride be added to the furnace charge in the form of calcium boride. The increase in the mass exchange between the depth and surface layers of the glass forming material in the oven results in higher losses of B_2O_3. (JPRS)

22159 YTTRIUM OXIDE FILMS PREPARED BY ELECTRON-BEAM EVAPORATION. Sayer, M. (Queen's Univ., Kingston, Ont.); Martin, M. Suzanne; Hellicar, N. J. Thin Solids Films; 6: R61-3(Nov 1970).

Data and information on the dielectric constant, dielectric strength, dissipation factor, temperature coefficient of capacitance of electron beam-evaporated Y_2O_3 films, are presented. (J.R.D.)

22160 INCONGRUENT VAPORIZATION OF NONSTOICHIOMETRIC $YbC_{1.25+y}$. Haschke, John M.; Eick, Harry A. (Michigan State Univ., East Lansing). Contract AT(11-1)-716. High Temp. Sci., 2: 376-80(Dec 1970).

The vapor pressure of gaseous ytterbium in equilibrium with $YbC_{1.25+y}$(s) [$0.12 \leq y \leq 0.16$] and YbC_2(s) was measured by a target collection Knudsen effusion technique over the temperature range 1056 to 1337°K, and is represented by the binomial equation $\log P_{Yb}(atm) = (3.03 - 6.56/T + 2.93/T^2) \pm 0.11$. From third law calculations the enthalpy of formation of $YbC_{1.25+y}$ was found to vary from -14.3 ± 0.1 ($y = 0.12$) to -16.1 ± 0.1 kcal/gfw ($y = 0.15$). (auth)

22161 CHEMICAL AND MECHANICAL BEHAVIOR OF INORGANIC MATERIALS. Accademia Nazionale dei Lincei Eleventh Course of the Guido Donegani Foundation, Tremezzo (Lake Como), Italy, September 8–20, 1968. Searcy, Alan W.; Ragone, David V.; Colombo, Umberto (eds.). New York; John Wiley and Sons, Inc. (1970). 737p. $27.50. (CONF-680940).

A total of 29 chapters are included in the book. A separate abstract was prepared for each of 10 chapters. The remaining 19 chapters are concerned with: thermodynamics of reactions, defects in solids and surfaces; nonstoichiometry; surface and bulk properties of ceramics; diffusion; nucleation and phase transformations; glasses; electrons as chemical entity in solids; mechanical properties of fiber-reinforced materials; technical ceramic fabrication; ceramic-based battery systems for automotive traction; geochemistry and ceramics; and the earth as a ceramic body. (G.M.C.)

For abstracts of individual chapters see: 22143, 22162–22167, 22183, 22184, and 22206.

22162 ENTHALPY AND PREDICTIONS OF SOLID-STATE REACTION EQUILIBRIA. Searcy, Alan W. (Univ. of California, Berkeley). pp 33-55 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

Correlations between the position of an element in the periodic table and the stability of the element and of its compounds toward high-temperature solid state reactions are described. Information is given on: stabilities of solid oxides and enthalpies of formation and stabilities of borides, carbides, nitrides, silicides, and intermetallic solids. (G.M.C.)

22163 REACTIONS OF HIGH-TEMPERATURE MATERIALS. Searcy, Alan W. (Univ. of California, Berkeley). pp 57-79 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

The thermodynamic stabilities of inorganic materials toward a broad range of reactions that might occur in possible conditions of use were examined. Information is given on: stabilities in ternary refractory systems; stability of oxides toward gases and reactions that produce gases; calculation of maximum reaction rates from thermodynamic data; and the stability of carbides and oxides in various chemical environments. (G.M.C.)

22164 UNFAMILIAR VAPOR MOLECULES AND THEIR IMPORTANCE IN HIGH-TEMPERATURE CHEMISTRY. De Maria, G. (Univ., Rome). pp 81-105 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

The properties of a few classes of molecules that are of interest in high-temperature chemistry are discussed. Some useful generalizations regarding the prediction of the stabilities of molecules in high-temperature gas systems are given for: homonuclear diatomic molecules of elements; homonuclear polyatomic molecules; heteronuclear diatomic molecules; vaporization of borides, metal halides, nitrides, oxides; and gaseous carbide molecules. (G.M.C.)

22165 MECHANICAL BEHAVIOR OF CERAMIC MATERIALS. II. PLASTIC FLOW AND FRACTURE. Conrad, Hans (Univ. of Kentucky, Lexington). pp 333-90 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

The nature of plastic flow and fracture in ceramics is discussed, with special attention given to the mechanisms associated with the mechanical behavior and the conditions leading to ductility. Some areas covered include: slip systems; macroscopic mechanical behavior; microplasticity; grains and grain boundaries; creep; nucleation and propagation of cracks; and effect of temperature and environment on fracture stress. (G.M.C.)

22166 MECHANICAL BEHAVIOR OF CERAMIC MATERIALS. III. DEFORMATION AND FRACTURE RELATED TO DESIGN AND USE. Conrad, Hans (Univ. of Kentucky, Lexington). pp 391-411 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

Some aspects of the mechanical behavior of ceramics that are of particular interest in their use as structural materials are considered. Topics discussed include: elastic and anelastic deformation; strength of ceramics; test-specimen design; statistical treatment of fracture; stresses; microstructure; effect of environment, size, strain rate, and temperature; and creep and creep fracture. (G.M.C.)

22167 MATERIALS FOR NUCLEAR TECHNOLOGY. Nevitt, M. V.; Duffield, R. B. (Argonne National Lab., Ill.). pp 615-35 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

Aspects of the properties and the performance of materials that are uniquely significant in nuclear technology, especially in reactor technology and isotope power applications, are reviewed. Topics discussed include: functional and nuclear characteristics of nuclear materials; functional performance in terms of properties and structure of reactor fuel matrix, fuel cladding, and radioisotope heat sources. (G.M.C.)

22168 HIGH-TEMPERATURE STRENGTH OF DISPERSION-STRENGTHENED COPPER. Pashkova, O. A.; Makarova, N. I.; Zhuk, N. P.; Opara, B. K. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 136-40(1970). (In Russian).

The effects of dispersoids on the high-temperature strength of Cu were studied. Electrolytic Cu was strengthened by powder metallurgy additions of Cr-0.4%; Cr_2O_3-0.58 and 1%; ZrO_2-1.0, 3.0, and 5%; and ThO_2-3%. It was found that alloying Cu with ZrO_2 and ThO_2 increases its high-temperature strength. These results are interpreted in a model in which the cation vacancies are filled in the Cu_2O lattice by Zr^{+4} and Th^{+4} ions accompanied by a decrease of diffusion rates by oxide films formed by ZrO_2 and ThO_2 as independent phases. The oxidation of Cu containing ThO_2 and ZrO_2 at 600 to 700°C is accompanied by an increase of scale and microcavities, or an accumulation of oxide particles of the alloying elements on the metallic surfaces. A mechanism for strengthening metallic systems by oxide additions is proposed. (tr-auth)

22169 SELECTION OF INDENTER MATERIAL FOR HIGH-TEMPERATURE MICRO-HARDNESS TESTING. Skuratovskii, V. N.; Dzhemelinskii, V. V.; Borisenko, V. A. Probl. Prochnosti; No. 6, 100-1(Dec 1969). (In Russian).

Microhardness testing methods are discussed and the variation of microhardness with temperature (0 to 1600°C) for B_4C, HfC, ZrC, Mo_2C, and artificial sapphire is given. (Metals Abstr.)

22170 GOVERNING EQUATIONS FOR SHELLS OF PYROLYTIC GRAPHITE-TYPE MATERIALS. Daugherty, R. L.; Kliger, H. S.; Vinson, J. R. (Univ. of Delaware, Newark). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: 508-10(Mar 1971).

Pyrolytic graphite and related materials are useful owing to its high strength-to-weight ratio at elevated temperatures. Shell equations are integrated for equilibrium equations, stress–strain relations with thermal effects, stress resultants and couples, and Q. (D.L.C.)

22171 RESEARCH ON METALLIC BASE COMPOSITES. Sherby, Oleg D.; Shyne, John C. (Stanford Univ., Calif.). Nav. Res. Rev.; 23: 12-19(May 1970).

Trends and advances regarding the development of metallic base composites are discussed taking into consideration fiber composites and particulate composites. The advantages and weaknesses of composites are briefly examined. Currently, major emphasis is being placed on filament-metal composites, where the filaments are elastically strong and have yield strengths. Examples of such filaments are silicon carbide, sapphire, boron, and graphite. A new method of preparing dispersion hardened composites which results in non-directional mechanical properties is discussed. Tensile bars of zinc containing various amounts of tungsten particles are shown. It is pointed out that a particulate composite of aluminum containing fifty percent boron should have a Young's modulus of about 30 million psi. (IAA)

22172 WETTING OF ALUMINUM, MAGNESIUM, AND ZIRCONIUM OXIDES AND VANADIUM, TITANIUM, AND ZIRCONIUM CARBIDES AND BORIDES WITH PALLADIUM MELTS. Vatolin, N. A.; Ukhov, V. F.; Esin, O. A.; Dubinin, E. L. Tr. Inst. Met., Sverdlovsk.; No. 20 42-54(1969). (In Russian).

The wetting of Al_2O_3, MgO, ZrO_2, and TiB_2, VB_2, ZrB_2, and the corresponding carbides by Pd and Pd alloys with Ag, W, was studied at 1600 to 2000°C and the results were expressed in the form of wetting angle and adhesion isotherms. In general the wetting angle for Al_2O_3 tended to fall with increasing temperature; on increasing the amounts of Co, Fe, Pb, Sb, and Cu in the alloys the work of adhesion fell, and on increasing the amounts of W, Ni, Cr, Mn, Al, and Si it rose. With increasing time the wettability of TiB_2, VB_2, ZrB_2, TiC, VC, and ZrC by Pd and Pd alloys rose considerably; complete spreading occurred on the carbides. (Metals Abstr.)

22173 DIFFUSION OF CARBON IN THE CARBIDES OF NIOBIUM. Fujikawa, Yoshimichi (Osaka Univ.); Son, Pongun; Miyake, Masanobu; Sano, Tadao. J. Jap. Inst. Metals; 34: 1259-63(Dec 1970). (In Japanese).

The reaction between niobium and graphite over the temperature range 1700 to 2200°C was investigated. The reaction products were found to be Nb_2C and NbC which formed between the graphite and the metal. Parabolic growth behavior was observed for both phases. The rate constants for layer growth can be expressed as $K_{Nb_2C} = 0.092 \exp[-(72.8 \pm 6.0/RT)$ kcal/mole] cm^2/sec and $K_{NbC} = 0.20 \exp[-(77.1 \pm 3.2/RT)$ kcal/mole] cm^2/sec. The diffusion coefficients of carbon in Nb_2C and NbC were estimated to be $D^C_{Nb_2C} = 2.3 \times 10^{-3} \exp[-(39.0 \pm 3.9/RT)$ kcal/mole] cm^2/sec and $D^C_{NbC} = 0.35 \exp[-(74.2 \pm 2.7/RT)$ kcal/mole] cm^2/sec, assuming that D is independent of concentration. (auth) (Japan)

22174 STUDY OF THE BREAKDOWN OF ALUMINOSILICATE, BORON-NITRIDE CONTAINING REFRACTORIES. Gogotsi, G. A.; Kuriat, R. I.; Terekhovskii, B. I.; Tresvyatskii, S. G. (Institut Problem Prochnosti, Kiev. Institut Problem Materiialovedeniia, Kiev). Probl. Prochnosti; 2: No. 3, 47-50(Mar 1970). (In Russian).

The initiation of cracks and the breakdown under thermal stresses of refractories containing varied amounts of boron nitride were examined. It was found that the best heat resistance under thermal stresses was exhibited by refractories containing from 40 to 50% boron nitride. Using a microscopic analysis, the best composition of refractories with respect to self-healing properties of cracks was determined. (IAA)

22175 SPECIFIC HEAT OF URANIUM AND PLUTONIUM OXIDES AT HIGH TEMPERATURES. Affortit, Christian; Marcon, Jean-Pierre (CEA, Fontenay-aux-Roses, France). Rev. Int. Hautes Temp. Refract.; 7: 236-41(Jul-Sep 1970). (In French).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

The specific heat of the compounds UO_{2+x} and $(U, Pu)O_{2\pm x}$ was measured by a dynamic method between 1600°K and the melting point. An increase of the specific heat with temperature, and a large variation with the ratio O/M were observed. This last point was connected with the variation of partial molar free energy with temperature and the following value was obtained for UO_{2+x} : $0.13 - 0.256.10^{-3}T$ (cal/mole/°K²). (auth) (France)

22176 ENTHALPY AND HEAT CAPACITY OF U_3O_8 BETWEEN 273 AND 1,000°K. Maglic, K.; Herak, R. (Boris Kidric Inst. for Nuclear Science, Belgrade). Rev. Int. Hautes Temp. Refract.; 7: 247-51(Jul-Sep 1970).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

An apparatus for the accurate measurement of specific heat using the drop method was built. The calibration factor of Bunsen ice calorimeter was determined electrically. The enthalpy of U_3O_8, which was obtained by calcination of the ammonium diuranate at 1023°K, was measured. The specific heat was derived from enthalpy data. The results obtained confirm the existence of a thermal discontinuity at 481°K. (auth) (France)

22177 DEVELOPMENTS IN THE FLASH METHOD FOR THE MEASUREMENT OF THERMAL DIFFUSIVITY. Murfin, D.

XUM

(British Ceramic Research Association, Stoke-on-Trent, Eng.). Rev. Int. Hautes Temp. Refract.; 7: 284-9(Jul-Sep 1970).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

The heat conduction equation applied to the flash method was solved for two-layer composite specimens. After the initial stages of the transient, governed by higher order terms in its Fourier analysis, the temperature difference produced by the flash decrease exponentially to zero. The principle is applied to the measurement of the thermal diffusivity of beryllia discs 1.7 mm thick, used as power transistor bases. A second apparatus uses a PbS cell and an arrangement of mirrors to measure the temperature difference between the opposite faces of a cylindrical specimen. (auth) (France)

22178 MEASUREMENT OF THERMAL DIFFUSIVITY AND TOTAL EMISSIVITY OF SOLIDS BETWEEN 1,500°K AND MELTING POINT. Faucher, M.; Cabannes, F.; Anthony, A. M.; Piriou, B.; Simonato, J. (CNRS, Orleans, France. Orleans Univ., France). Rev. Int. Hautes Temp. Refract.; 7: 290-7(Jul-Sep 1970). (In French).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

A small cylindrical sample was heated using an arc imaging furnace. By a photographic method, the distributions of the surface temperatures were obtained during the cooling, when the heating radiation is cut off. By solving the Laplace equation in order to have initial conditions and Fourier equation during the cooling, the ratio ϵ_T/λ of total emissivity to thermal conductivity is obtained, as also the thermal diffusivity. Refractory compounds such as ZrO_2, Y_2O_3, and ThO_2 were studied at 1500°K to the melting point. (France)

22179 DETERMINATION OF OXYGEN/METAL RATIOS FOR URANIUM, PLUTONIUM, AND (U,Pu) MIXED OXIDES. McNeilly, C. E.; Chikalla, T. D. (Battelle-Northwest, Richland, Wash.). J. Nucl. Mater.; 39: 77-83(Apr 1971).

A technique was developed for determining the oxygen-to-metal ratio of nonstoichiometric uranium, plutonium, and mixed uranium-plutonium oxides. This technique was based on determining the weight change which occurred when the nonstoichiometric oxide was heated at 800°C for six hours in an atmosphere in which the oxygen potential was maintained at approximately −101 kcal/mole O_2. An atmosphere of this composition resulted in an O/M ratio of 2.00 regardless of whether the starting oxide was hyper- or hypostoichiometric and was applicable from 0 to 100% PuO_2 in UO_2. Results for a series of measurements on identical samples indicated a precision of ±0.001 O/M units. The accuracy was evaluated by a series of oxidations on high purity uranium and plutonium metals and found to be better than ±0.005 O/M units. (auth)

22180 ENTHALPY OF LIQUID URANIUM DIOXIDE TO 3500°K. Leibowitz, L.; Chasanov, M. G.; Mishler, L. W.; Fischer, D. F. (Argonne National Lab., Ill.). J. Nucl. Mater.; 39: 115-16(Apr 1971).

The enthalpy relative to room temperature of liquid UO_2 was measured at 3173 to 3523°K with an adiabatic calorimeter. A double-walled tungsten capsule held the sample. The liquid UO_2 data could be represented by: $H_T^0 - H_{298}^0 = 32.457T - 11,153.8$. From the experimental results the heat of fusion of UO_2 was found to be 17.7 kcal/mole. (G.M.C.)

22181 MECHANICAL PROPERTIES OF DISPERSION-HARDENED COBALT IN THE RANGE -196 TO 800°C. Voinitskii, A. G.; Petrova, E. M.; Shcherban, N. I. Probl. Prochnosti; No. 6, 84-7(Jun 1970). (In Russian).

The effect of TiC and NbC was studied. Dispersion hardening can increase the strength of pure Co 2 to 3 times while maintaining satisfactory plasticity. At higher temperatures the strength properties and stability achieved their optimum values with carbide contents of 4 to 8%. The substitution of NbC by TiC increased the UTS and flow stress over the whole temperature range. It is shown that Kurnakov's analytical expression for the temperature dependence of the mechanical properties of metals and alloys can be applied to materials prepared by powder metallurgy. (Metals Abstr.)

Structure and Phase Studies

Refer also to abstracts 20918, 22643–22645, and 22653.

22182 ELECTRON MICROSCOPY STUDY OF THE UO_2–SiO_2 VITROCERAMICS. Teodorescu, I.; Glanz, G. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 22: 591-8(1970). (In Rumanian).

The microstructure of the UO_2–SiO_2 vitroceramics, as a function of the uranium dioxide concentration, is studied by replica electron microscopy. Structurally, in the concentration range of 10 to 72 vol % UO_2, there are two phases: a microcrystalline UO_2 phase and a vitreous SiO_2 phase. The ratio of concentration of the system components determines the structure form in which these two phases coexist. At small concentrations of UO_2 (≤50%), the structure formed by particles or islands of UO_2, dispersed in the vitreous SiO_2 phase, is predominant. On the contrary, at the higher UO_2 concentrations (≥60%), the SiO_2 phase appears as islands embedded in the microcrystalline UO_2 matrix or in the form of a "pellicule" which encloses zones rich in UO_2. The phases of the UO_2–SiO_2 system are not pure. (auth)

22183 MECHANICAL BEHAVIOR OF CERAMIC MATERIALS. I. DISLOCATION THEORY. Conrad, Hans (Univ. of Kentucky, Lexington). pp 285-332 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

Certain characteristics and properties of dislocations are reviewed that are important to understanding their role in the mechanical behavior of crystalline solids in general and of ceramics in particular. Information is given on: geometrical aspects of dislocation lines; properties of dislocations; obstacles to dislocation motion; thermally activated dislocation motion; dislocations in ceramic crystals; and experimental observations on dislocations. (G.M.C.)

22184 STRUCTURE AND PROPERTIES OF PYROLYTIC CARBON. Bokros, J. C. (Gulf General Atomic, San Diego, Calif.). pp 553-83 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

Basic background material on pyrolytic carbon is summarized. The relations between the structure and properties of pyrolytic carbon are illustrated. Information is given on: structure; dependence of structure on deposition conditions; dependence of mechanical properties, thermal expansion, and radioinduced dimensional changes on structure; and new applications of high-strength carbons deposited in fluidized beds. (G.M.C.)

22185 CHEMISTRY OF EXTENDED DEFECTS IN NON-METALLIC SOLIDS. Proceedings of the Institute for Advanced Study, Scottsdale, Arizona, April 16–26, 1969. Eyring, LeRoy; O'Keeffe, Michael (eds.). Amsterdam; North-Holland Publishing Company (1970). 680p. (CONF-690450).

Separate abstracts were prepared for 15 of the 37 papers included. The remaining papers were not within the scope of NSA. (A.G.W.)

For abstracts of individual papers see: 22186–22193, 22205, 22642–22645, 22652, and 22653.

22186 ROLE OF OXYGEN PRESSURE IN CONTROL AND MEASUREMENT OF COMPOSITION IN 3d METAL OXIDES. Reed, T. B. (Massachusetts Inst. of Tech., Lexington). pp 21-35 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

The 3d metals from Sc through Zn exhibit a variety of valence states in their oxides. More than 35 oxides exist for these ten metals. The published thermodynamic data for the 3d metal oxides are summarized in extended pressure–composition phase diagrams for 1000°K, which gave the range of oxygen pressure over which each compound is stable. The deviation from stoichiometric composition is also shown in the diagrams and is summarized in a table which relates this range to the range of oxygen pressure over which each compound is stable. It is observed that in general the range of oxygen pressure varies inversely with the width of the composition range. Oxygen pressure uniquely determines the compound formed and the deviation from the ideal stoichiometry for each metal, and so it is important in preparing oxides to control this pressure. Methods of controlling and measuring this pressure over about 50 orders of magnitude are discussed. Some techniques for synthesis and crystal growth of these oxides are summarized. The limitations of chemical analysis are outlined, and other techniques are described by which the composition can be more accurately measured. (auth)

22187 THERMODYNAMIC AND X-RAY DIFFRACTION BEHAVIOR OF A WIDELY NONSTOICHIOMETRIC REGION OF THE PRASEODYMIUM OXIDE SYSTEM. Jenkins, M. S.; Turcotte, R. P.; Eyring, L. (Arizona State Univ., Tempe). pp 36-53 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

A thermogravimetric isobaric technique was used to derive partial molar thermodynamic quantities for the incorporation of oxygen into nonstoichiometric praseodymium oxide in the α-phase region in the temperature range 400 to 800° and at various constant oxygen pressures from 38 to 730 torr. Under these conditions, the α region has been believed to be a single phase having a composition range $\sim 1.830 \geq O/M \geq \sim 1.785$. The striking feature in this work is the apparent existence of four discrete families of curves in the free energy versus temperature plot. This detailed analysis of the thermodynamic data shows the α free-energy surface to have fine structure. Derived thermodynamic quantities are compared with those of related systems and are seen to extend a trend in the behavior of oxygen-deficient fluorite-type oxides. High-temperature x-ray diffraction studies were made during isobaric runs over the same ranges of temperature and pressure as in the tensimetric experiments. The results give qualitative support to the tensimetric studies showing texture in the α region. The data are further analyzed to give information about the dependence of the lattice parameter on composition or temperature independently. A qualitative analysis of line profiles indicates broadening due to strain rather than particle size. (auth)

22188 PLUTONIUM CHALCOGENIDES. Allbutt, M.; Dell, R. M.; Junkison, A. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 124-47 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

The preparation and crystallography of several phases in the Pu–S, Pu–Se, and Pu–Te systems is described. Previous reports of high melting-point face-centered-cubic monochalcogenides PuS, PuSe, PuTe are confirmed. A wide range of homogeneity from Pu_3X_4 to Pu_2X_3 is found for body-centered-cubic γ-Pu_2S_3 and γ-Pu_2Se_3 phases and from $PuX_{1.8}$ to $PuX_{2.0}$ for tetragonal PuS_{2-x}, $PuSe_{2-x}$, and $PuTe_{2-x}$ phases. The lower chalcogenides PuX and Pu_3X_4 are good electrical conductors. Hexagonal oxy-chalcogenides Pu_2O_2S and Pu_2O_2Se and tetragonal Pu_2O_2Te are described. Plutonium chalcogenides strongly resemble their rare earth counterparts, specifically cerium and neodymium. A ternary eutectic PuS–Pu_3S_4–Pu_2O_2S is found to influence the sintering behavior of PuS. The magnetic susceptibility of PuS, PuSe, and PuTe between 100 and 300°K is reported and these compounds are shown to be almost temperature-independent paramagnets. Finally, the resemblance between the crystallography of the plutonium–oxygen and uranium–nitrogen and the plutonium–sulfur and uranium–phosphorus systems is pointed out. (auth)

22189 STRUCTURAL ORDER AND DISORDER IN OXIDES OF TRANSITION METALS OF THE TITANIUM, VANADIUM, AND CHROMIUM GROUPS. Magneli, Arne (Univ. of Stockholm). pp 148-63 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

X-ray crystallographic investigations of binary and ternary oxides of the titanium, vanadium, and chromium group elements have contributed appreciably to the understanding of the structural and phase relations in these and other complicated systems. The concepts of crystallographic shear and homologous series of structures, which emerged from investigations of molybdenum and tungsten oxides, have been successfully applied to describe the general architecture and also to calculate ideal geometric properties of known and hypothetic families of structures. X-ray studies also show that real oxide structures frequently exhibit interesting deviations from the ideal ones. Such deviations may be due to the existence in the real structure of a different, more complicated pattern of order or they may be associated with some kind of structural disorder. Results are presented which illustrate various states of order and disorder in real oxide structures. Mistakes in the system of shear give rise to aperiodic structures in molybdenum tungsten and titanium chromium oxides or to twinning in e.g., molybdenum tungsten oxides. Sub-stoichiometric tungsten and molybdenum oxides show structural characteristics which may be discussed in terms of alternative possibilities of shear in the parent tungsten trioxide or molybdenum trioxide structures. Ordered and disordered patterns of off-center displacements of the metal atoms of MO_6 octahedra exist in binary and ternary oxides of vanadium, molybdenum, and tungsten. Intermediary chromium oxides exhibit a segregation of metal atom valences on different atomic sites in contrast to finding for molybdenum oxides. Shear structures of ternary vanadium molybdenum and vanadium tungsten oxides possess non-uniform distributions of the metal atom species. (auth)

22190 CHEMICAL AND STRUCTURAL INVESTIGATIONS IN THE Ta_2O_5–WO_3 SYSTEM. Roth, R. S.; Stephenson, N. C. (National Bureau of Standards, Washington, D. C.). pp 167-82 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

Crystal structures have been determined for the compounds $Ta_{22}W_4O_{67}$, $Ta_{10}W_2O_{31}$, $Ta_{74}W_2O_{191}$, and Ta_2O_5. These compounds are stable phases in the Ta_2O_5–WO_3 system and have unit cells which are based respectively, on 13, 8, 19, and 11 UO_3-type subcell units. Metal atoms are either octahedrally coordinated to six oxygen atoms or else surrounded by seven oxygen atoms in the form of a pentagonal bipyramid. On the basis of these structures, a building-block scheme is developed which enables the ideal, or undistorted, structure to be predicted for any member of the hundreds of compounds which form a continuous series of structures in the region Ta_2O_5–$11Ta_2O_5 \cdot 4WO_3$. Anionic packing distortions occur in the ideal structures. In the real structures these distortions are minimized by a reduction in the coordination number of some seven-coordinated metal atoms. These atoms form distortion-sheets throughout the structure. The importance and distribution of these distortion-sheets is discussed. (auth)

22191 CRYSTAL STRUCTURES OF ZrS AND $Zr_{8\ 77}S$. Conrad, B. R.; Franzen, H. F. (Ames Lab., Iowa). pp 207-19 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

The crystal structures of ZrS and $Zr_{0.77}S$ have been determined from single-crystal x-ray diffraction data. ZrS has the NaCl-type structure with a = 5.16 Å. $Zr_{0.77}S$ has a superstructure of the NaCl-type structure in which the ordering of zirconium vacancies is monoclinic, space group C2/m, with lattice parameters a = 10.35 Å, b = 10.31 Å, c = 7.33 Å, β = 135.06°. The unit cell contains sixteen formula units. Percent occupancies of zirconium sites and positional parameters of sulfur atoms are determined from 165 superstructure structure factors and two fundamental structure factors. There are, within experimental error, four different zirconium occupancy parameters. The non-stoichiometric compound with 23% of the zirconium sites vacant exhibits lattice distortions and sulfur positional shifts, relative to the NaCl-type structure, which have very slight experimental significance. (auth)

22192 POINT, LINE, AND PLANAR DEFECTS IN SOME NONSTOICHIOMETRIC COMPOUNDS. Hyde, B. G.; Bursill, L. A. (Univ. of Western Australia, Nedlands). pp 347-78 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

Some recent electron microscope investigations of the reduction of NbO_2F, V_2O_5, MoO_3, and TiO_2 are reviewed. The results go some way towards establishing models for reduction processes, especially in crystals prone to crystallographic shear. They show the prevalence of hybrid crystals when reactant and product are closely related in structure, and suggest that phase reactions may be continuous (Ubbelohde). Some difficulty in establishing thermodynamic data for e.g. $TiO_x + O_2$ are thereby explained and the nature of microdomain textures partly clarified. (auth)

22193 VACANCY FILLING IN TITANIUM MONOXIDE AND SIMILAR SEMIMETALS. Taylor, A.; Doyle, N. J. (Westinghouse Research Labs., Pittsburgh). pp 523-40 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

The cubic NaCl-type monoxides, TiO, VO, and NbO are unusual on account of the large number of vacant sites present on both the

metal and oxygen sublattices. It has been found that in the absence of applied pressure, the number of vacancies of each type in TiO increases as the annealing temperature is increased, but decreases as pressure is applied, the number of vacancies dropping from 14.4% to zero when $P\Delta T > 90{,}000$ kbar · °C, where P is the applied pressure and ΔT is the temperature above ambient at which the pressure is applied. It has been found that any required number of vacancies, ranging from 14.4 to 0.0% can be obtained by the correct selection of $P\Delta T$, and the process is completely reversible in that reheating samples in the absence of applied pressure causes them to revert to the original vacancy level of 14.5%. The removal of the vacancies is accompanied by a rise in lattice parameter from 4.1796 to 4.2062 Å, the rise being roughly proportional to the product $P\Delta T$. The density over this range increases from 4.97(3) to 5.69(9) g/cm^3. Removal of the vacancies causes the superconductive transition temperature to rise from 0.7°K to 2.3°K; the compressibility is reduced, on filling the vacancies, from $5.5(8) \times 10^{-13}$ to $4.2(8) \times 10^{-13}$ cm^2 · dyne^{-1}, and the coefficient of thermal expansion at 25°C changes from 6.73×10^{-6} to 6.30×10^{-6} deg^{-1}. The Grueneisen constant for TiO with 14.4% vacancies was computed as $\gamma = 1.18$. The combined action of pressure and temperature on VO produces vacancy-filling as in TiO, but no vacancy filling takes place in NbO where the vacancies are ordered. (auth)

22194 PHASE COMPOSITION OF THE PRODUCTS OF THE INTERACTION BETWEEN VANADIUM, NIOBIUM, AND TANTALUM AND THEIR HIGHER OXIDES AT ABOUT 400°C. Alyamovskii, S. I.; Shveikin, G. P.; Gel'd, P. V. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 17, 23-4(1970). (In Russian).

In connection with the oxidation of V, Nb, and Ta and the dissolution of O in these metals, the products of the interactions between the metals and the corresponding higher oxides, e.g., V_2O_5, were studied. In the V–O and Nb–O systems the phases V_4O, V_2O, VO, and NbO were observed by x-ray diffraction. In the Ta–O system there was a solid solution of O in Ta as well as an unknown phase, possibly Ta_2O. These phases may also be formed when the metals are vacuum-deposited on heated substrates. (Metals Abstr.)

22195 SOLID SOLUTION OF OXYGEN IN ALPHA-HAFNIUM. Shveikin, G. P.; Alyamovskii, S. I.; Gel'd, P. V.; Bausova, N. V. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 17, 34-7 (1970). (In Russian).

The nature of the solid solution formed by O in α-Hf was studied by x-ray diffraction and the results were correlated with existing data relating to Ti and Zr as well as Hf. The Hf samples dissolved ~20 at. % O, as indicated by the lattice constant/composition diagrams so plotted. These results agreed with some sets of existing data but disagreed with others. The reasons for the discrepancies (discussed at length) lay partly in the purity of the materials studied, and partly in the types of atomic bond formed. (Metals Abstr.)

22196 STUDIES OF STRONTIUM URANATES. Brisi, Cesare; Montorsi, Margherita; Acquarone, Giuseppina Burlando. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 104: 681-92(Nov-Dec 1970). (In Italian).

Products obtained by calcination of strontium oxide and uranium oxide in air were studied. Five uranates were identified corresponding to the formulas Sr_3UO_6, Sr_2UO_5, $Sr_3U_2O_9$, $SrUO_4$, and $Sr_2U_3O_{11}$. Sr_2UO_5 decomposed at 1370°C in a mixture of Sr_3UO_6 and $SrUO_{4-x}$; $Sr_3U_2O_9$ was stable only between 1170 and 1325°C. Monostrontium uranate lost oxygen at 1230°C giving a phase $SrUO_{4-x}$ in which x was very near to 0.3. Between this phase and $Sr_2U_3O_{11}$ a continuous series of mixed crystals existed, which were stable in air at temperatures lowering with the increasing of the ratio uranium/strontium. In the zone of the uranium-rich system a new phase was found corresponding to the formula $SrU_4O_{12.8}$, which decomposed at 1120°C in a mixture of $Sr_2U_3O_{11}$ and U_3O_8. At temperatures higher than 1330°C the formation of a phase with fluorite structure of $Sr_{0.2}U_{0.8}O_{2.05}$ was also possible. (auth)

22197 AGING OF BORON NITRIDE CRYSTALS AS INVESTIGATED BY THE CHEMICAL ETCHING METHOD. Filonenko, N. E.; Mishina, L. I. (All-Union Inst. of Studying Abrasives Materials and Polishing Techniques, Leningrad). Dokl. Akad. Nauk SSSR; 195: 1088-9(11 Dec 1970). (In Russian).

Boron nitride crystals with sphalerite structure were prepared by phase transformation from hexagonal boron nitride. The most developed counterfaces (111) and $(\bar{1}\bar{1}\bar{1})$ had a visual specular-smooth microrelief. The chemical pickling of crystals was performed by KOH melt at 380°C with the duration of 30 min and 1, 2, 4, and more hours. Micromorphological analyses of pickled surfaces (111) and $(\bar{1}\bar{1}\bar{1})$ and their photography showed that the $(\bar{1}\bar{1}\bar{1})$ faces, despite the duration of pickling, retained their specular surface and the pickling pits revealed only various crystal structure defects. Phase pickling of the (111) surface revealed sectorial and zonal crystal structure with various changes depending on the duration of pickling time. (R.V.J.)

22198 THERMAL LATTICE EXPANSION MEASUREMENTS ON CARBON POWDERS UP TO GRAPHITIZATION TEMPERATURES. Braun, W.; Christu, N.; Fitzer, E. (Technische Hochschule, Karlsruhe, Ger.). Rev. Int. Hautes Temp. Refract.; 7: 257-63(Jul-Sep 1970).

From 2nd European Conference on Thermophysical Properties of Solids at High Temperatures, Salford, England. See CONF-700431.

A description is given of a method for determining by x-ray diffraction the layer distance c/2 of carbon powders at temperatures up to the level of thermal graphitization. The powder samples were incorporated in a matrix of vitreous carbon, the latter being used as a heating element in a high temperature x-ray chamber. The matrix is chemically inert with respect to the powdered sample and its (002) x-ray reflection is very broad and diffuse. Therefore the (002) reflections of the powder samples are not influenced by the matrix and can be used for a determination of the interlayer spacing c/2. Determination was made of both the reversible thermal lattice expansion of graphitized samples up to 2300°C and of the irreversible lattice contraction of nongraphitized samples and the results are discussed. (auth) (France)

22199 INFLUENCE OF Cu ADMIXTURES ON THE LATTICE PARAMETERS IN MONOCLINIC MODIFICATION OF ZrO_2. Dereberya, N. A.; Korduba, B. M.; Shevchuk, L. P. (Inst. of Polygraphy, Kiev). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 110-13(1970). (In Russian).

The influence of Cu impurities on ZrO_2 lattice parameters was studied using ZrO_2 powders of monoclinic modification and Cu powder of 98.88 and 99.855% purity, respectively. Calculated parameters of the ZrO_2 monoclinic lattice with the impurities, tabulated for the 4 hr sintering at 1200°C, showed that the interplanar distances in the monoclinic ZrO_2 lattice decreased with additions of 0.1 to 3% Cu. (R.V.J.)

22200 STRUCTURE OF TANTALUM NITRIDES. Terao, Nobuzo (Union Carbide European Research Associates, Brussels). Jap. J. Appl. Phys.; 10: 248-59(Feb 1971).

The crystal structure of tantalum nitrides was examined by x-ray and electron diffraction techniques and the following seven phases are identified: $TaN_{\sim 0.05}$ (cubic, β-phase), Ta_2N (hexagonal, γ-phase), δ-TaN (hexagonal), ϵ-TaN (hexagonal), Ta_5N_6 (hexagonal), Ta_4N_5 (tetragonal), and Ta_3N_5 (tetragonal or monoclinic). Thin films of Ta nitrides for electron diffraction study were prepared by nitriding thin evaporated films of tantalum in ammonia and nitrogen. By heating thin films of Ta_3N_5 in vacuum, the phase transformations occurred successively as follows: $Ta_3N_5 \rightarrow Ta_4N_5 \rightarrow Ta_5N_6 \rightarrow \epsilon$-TaN $\rightarrow Ta_2N$. The structure of each nitride form is discussed. (auth)

22201 CRYSTAL STRUCTURE OF THE C-PHASE $V_2(Co_{0.57}Si_{0.43})_3$: A NEW EXAMPLE OF THE STRUCTURE OF THE HOMOLOGOUS Zr_4Al_3–$MgZn_2$ SERIES. Kripyakevich, P. I.; Yarmolyuk, Ya. P. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 10, 948-51(Oct 1970). (In Ukrainian).

The crystal structure of $V_2(Co_{0.57}Si_{0.43})_3$ (C-phase of the V–Co–Si system) was determined by single crystal x-ray analysis. The structure belonged to a new type (space group B2/m, a = 17.17, b = 7.55, c = 4.66 Å, $\gamma = 99.2^0$, N = 50). It represented a combination of the fragments of Zr_4Al_3- and $MgZn_2$-type structures ($R_4X_3 \cdot 3R_2X_4 = 5R_2X_3$, where R and X are respectively the atoms with coordination numbers 16, 15, 14 and 12) and formed the homologous series together with the types W_6Fe_7, $Nb_6(Ni,Al)_7$ ($R_4X_3 \cdot R_2X_4$) and $Mn_{14}(Co,Si)_{23}$ ($R_4X_3 \cdot 5R_2X_4$). (auth)

22202 INHIBITION OF GRAIN GROWTH IN NIOBIUM DIBORIDE. Murata, Yorihiro; Miccioli, Bruno R. (Carborundum Co., Niagara Falls, N. Y.). Amer. Ceram. Soc. Bull.; 50: 182-4 (Feb 1971).

Microstructural variations resulting from additions of transition metal nitrides, borides, and carbides were studied in the densification of hot-pressed niobium diboride. Titanium compounds, TiN in particular, were found effective for reducing grain size. In the NbB_2–TiN system, phases developed at 2100°C were hexagonal (Nb,Ti)B_2 solid solution, Nb_3B_4, and a TiN solid solution. Lattice parameters, grain size, and pore volume in the (Nb,Ti)B_2 phase decreased rapidly with increasing TiN content up to 8.9 mole %. The solubility limit of TiN in NbB_2 at 2100°C was about 8.9 mole %. (auth)

Radiation Effects

Refer also to abstracts 22133, 22631, and 23104.

22203 (AE-411) IN-PILE DETERMINATION OF THE THERMAL CONDUCTIVITY OF UO_2 IN THE RANGE 500 TO 2500 DEGREES CENTIGRADE. Gyllander, Jan-Ake (Aktiebolaget Atomenergi, Stockholm (Sweden)). Jan 1971. 71p. Dep. NTIS (U. S. Sales Only).

The thermal conductivity of stoichiometric UO_2 with a sintered density of 10.57 g/cm^3 was determined in-pile at 500 to 2500°C. The irradiation was performed in the gas-cooled loop of the R2 reactor at Studsvik, Sweden. The irradiation rig was moved in a vertical direction thus varying the neutron flux and hence the power output. The cooling gas was helium except for a short period at the end of the experiment when the gas was changed to argon. The instrumentation consisted of 5 thermocouples for temperature measurements and 4 β-current detectors for continuous relative power measurement. Pure cobalt wires as melting and neutron dose monitors were also inserted into the fuel. The thermal conductivity λ of UO_2 was found to be $\lambda = (6.4 + 0.0227 \times T)^{-1} + 0.50 \cdot 10^{-12} \times T^3$ W/cm · K with T in degrees Kelvin. (auth) (Sweden)

22204 (RT/ING-(70)15) IRRADIATION EXPERIMENTS ON CYRANUM CAPSULES FOR THE STUDY OF THE THERMAL BEHAVIOR OF FUEL RODS. RESULTS ON SAMPLES OF UO_2 IN PELLETS. Bini, A. Calza; Cosoli, G.; Filacchioni, G.; Lanchi, M.; Nobili, A.; Rocca, U.; Rotoloni, P.; Segre, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 9 Jul 1970. 85p. (In Italian). Dep. NTIS (U. S. Sales Only).

Irradiation experiments carried out on CYRANUM capsules are described. The purpose of these experiments was to study the thermal properties of ceramic fuel UO_2 and UO_2-PuO_2 rods, consisting of pellets and vibrocompacted powder. The results of the irradiations of the two first capsules containing pelleted UO_2, in RS-1 Avogadro Reactor at Saluggia, are reported. (auth)

22205 DIRECT OBSERVATIONS OF EXTENDED DEFECTS IN NONMETALLIC CRYSTALS CONTAINING NONEQUILIBRIUM POINT DEFECT CONCENTRATIONS. Ashbee, K. H. G. (Univ. of Bristol, Eng.). pp 323-46 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

Transmission-electron-microscopy observations were made of extended defects in thin-film single crystals of lanthanum trifluoride, rutile, and urania that were irradiated, rendered nonstoichiometric, quenched, or plastically deformed. The defects resulting from irradiation and plastic deformation are readily identified and include perfect dislocation loops. However, the defects observed in nonstoichiometric and in quenched crystals are more difficult to interpret. This is particularly true in urania, for which detailed studies are reported of the contrast seen in bright-field microscopy. Heating rutile in the microscope atmosphere (air at a pressure of 10^{-5} mm Hg) produces hypostoichiometry, and anion vacancies migrate to and anneal translation twins thereby creating cation interstitials. In the case of urania, the same treatment produces hyperstoichiometry, which manifests itself by changes in the lattice parameter of surface layers and by precipitation of higher-oxide particles. Heating occasionally produces cavities in urania, the migrations of which have been photographed at regular intervals. Hypostoichiometry can be produced by quenching urania from very high temperatures in a reducing or inert atmosphere, and introduces defect surfaces adjacent to some dislocations. (auth)

22206 EFFECT OF NUCLEAR RADIATION ON THE MECHANICAL AND CHEMICAL PROPERTIES OF CERAMICS. Bowen, D. H.; Clarke, F. J. P. (Atomic Energy Research Establishment, Harwell, Eng.). pp 585-613 of Chemical and Mechanical Behavior of Inorganic Materials. /Searcy, Alan W. (ed.). New York; John Wiley and Sons, Inc. (1970).

From 1st International Conference on Materials Science, Tremezzo, Italy. See CONF-680940.

The effects of irradiation on some of the most extensively studied oxide ceramics, namely, uranium dioxide, aluminum oxide, beryllium oxide, and magnesium oxide, are reviewed. A brief outline of radiation damage processes in solids and their consequences is given. Topics discussed include: nuclear radiation; fission-induced changes in chemical composition; effect of radiation on chemical reactivity; effects of transmutations on composition of nonfissile oxides; defect structure; structural integrity and strength; hardness; elastic constants. (G.M.C.)

22207 ELECTRON-PROBE MICROANALYSIS OF IRRADIATED MATERIALS. Bramman, J. I.; Sharpe, R. M.; Yates, G. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). pp 387-401 of Physical and Fabrication Metallurgy. /Jones, M. J. (ed.). London; Institution of Mining and Metallurgy (1970).

From 9th Commonwealth Mining and Metallurgical Congress, London, England. See CONF-690561-(Vol.4).

The use of an electron-probe microanalyzer, specially modified to facilitate the examination of radioactive samples without significant loss of sensitivity, in the identification of second phases in irradiated ceramic fuels is described. The technique has provided invaluable evidence on the behavior of fission products. (auth) (UK)

22208 PREPRESSURIZATION ADDS LIFE TO PRESSURISED WATER REACTOR FUEL. Elec. World; 173: No. 7, 35(16 Feb 1970).

Tests have shown that prepressurization significantly reduced creep during 400 hr of irradiation and that the contact time between cladding and pellets is a function of the initial cold internal pressure. (Fuel Abstr.)

22209 X-RAY DIFFRACTION STUDIES OF ION-BOMBARDED U_3Si. Walker, D. G.; Morel, P. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.: 39: 49-58(Apr 1971).

The structural changes undergone by U_3Si under argon ion bombardment and subsequent annealing were examined by x-ray diffraction. For ambient temperature bombardment the structure degenerated through a disordered cubic modification to an amorphous phase; the change may involve faulting on prism planes. Cubic material annealed in a series of stages covering a wide temperature range whereas the amorphous phase transformed to the tetragonal phase at 290°C. This transition temperature was independent of ion fluence and of some compositional variations. For bombardments at temperatures above 250°C the cubic modification was formed below 300°C whereas the tetragonal phase was observed above this temperature. In general the changes found for argon ion bombardment correlate closely to those reported for neutron irradiated material. (auth)

Plastics and Other Materials

Refer also to abstracts 21011, 21013, 21025, 21026, 21159, 21268, 21274, 21275, 23270, and 23387.

22210 (CONF-700816-(Vol.2), pp 482-94) CHARCOAL TESTING WITH METHYL IODIDE USING A PYROLYZER-MICROCOULOMB DETECTOR. McFee, Donald R.; Bechtold, Ralph R. (Argonne National Lab., Ill.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

A pyrolyzer and a following (in series) Microcoulomb Detector were evaluated as a direct reading instrumental system for in-place testing of charcoal adsorbent bed filters, using normal methyl iodide as the test penetrant. Sensitivity was found to be about 2 parts per billion (ppb) by volume. The system can be used for scanning the face of a charcoal filter with a movable sampling probe to locate leaks, to make direct evaluations of the charcoal itself, and to make penetration tests of a total system. The alkyl iodides, especially methyl iodide, are some of the main radioiodine-containing contaminants that charcoal filters remove from off-gas systems for nuclear fuels. Charcoals showing a high efficiency for removal of methyl iodide can be expected to show a high efficiency for trapping other compounds of iodine. Thus, the high efficiency of a charcoal filter, an absence of leaks, and the overall uniform integrity of a system can be verified through in-place testing with methyl iodide. If, on the other hand, the efficiency for methyl iodide is found to be low, the filter still may prove efficient for other iodine compounds and must be judged on the basis of the compounds it is supposed to remove from the air stream, which may or may not be organic iodides. Tests conducted on the impregnated charcoal filters in the containment clean-up system for Argonne's CP-5 Research Reactor (5 megawatt) showed methyl iodide penetrations of 0.1 to 0.2%. Tests in the laboratory on fresh charcoal from the same lot showed penetrations of less than 0.01% until breakthrough occurred. Tests on other charcoal systems containing old, nonimpregnated charcoal showed penetrations ranging from a few percentage points to greater than 20%. (auth)

22211 (CONF-700816-(Vol.2), pp 581-99) STUDY OF THE ADSORPTION PROPERTIES OF METAL ZEOLITES FOR AIR-

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BORNE IODINE SPECIES. Pence, D. T.; Duce, F. A.; Maeck, W. J. (Idaho Nuclear Corp., Idaho Falls).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

Silver zeolite as an adsorbent for various species of airborne radioiodine was first discussed at the Tenth AEC Air Cleaning Conference. Because of the promising nature of this material, a more detailed investigation of the properties and characteristics of both silver zeolite and other materials for the adsorption of various airborne iodine species is being conducted. The objectives of this program are to thoroughly investigate the adsorption properties of silver zeolite, prepare and investigate the properties of other metal zeolites for airborne iodine species, to more fully evaluate the most promising materials, and finally to provide support for full scale testing. Current laboratory studies include various methods for the preparation of silver zeolite; methyl iodide adsorption as a function of humidity, temperature, face velocity, and bed depth; desorption of iodine; loading capacity as a function of airborne iodine species concentration and flow rate; and product solubility. Similar studies have also been conducted for other selected metal zeolites. A limited number of charcoal adsorption tests have been conducted to provide comparison data. (auth)

22212 (CONF-700816-(Vol.2), pp 607-20) APPLICATION OF METAL ZEOLITES TO RADIOIODINE AIR CLEANING PROBLEMS. Maeck, W. J.; Pence, D. T. (Idaho Nuclear Corp., Idaho Falls).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The use of fully loaded zeolite as an adsorbent for airborne iodine in reactor containment filter systems was first proposed by Idaho Nuclear Corporation at the Tenth Air Cleaning Conference. Since that time, detailed investigations of the iodine adsorption properties of silver and other metal-loaded zeolites have suggested several other potential applications for these materials. One important application is the removal of iodine from the off-gas of nuclear fuel processing plants. The high temperature operability of metal zeolites makes them attractive for this application. The use of tandem beds containing different metal-loaded zeolites and the advantages of using heated beds are discussed. An examination of the economics of metal zeolites shows the use of these materials to be practical for many iodine air cleaning applications. (auth)

22213 THERMAL CONDUCTIVITY OF ELECTRON-IRRADIATED CdS. Vook, Frederick L. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., B; 3: 2022-9(15 Mar 1971).

Measurements were made of the change in low-temperature thermal conductivity of high-resistivity sulfur-compensated single-crystal CdS upon electron irradiation and annealing. Samples oriented parallel and perpendicular to the hexagonal c axis of CdS were irradiated with 2-MeV electrons below 25°K to fluences Φ totaling 7.8×10^{17} electrons/cm^2. The increase in the additive thermal resistivity at 11°K on irradiation was found to be independent of the orientation of the sample, and $1/K - 1/K_0 = (5.5 \times 10^{-10})\ \Phi^{0.5}$ cm deg/W. Isochronal annealing measurements show almost complete annealing out of the additive thermal resistivity below room temperature, and recovery begins as low as 35°K. There are three major annealing stages centered near 45, 75, and 225°K. Annealing above 60°K produces an anisotropic thermal conductivity for subsequent measurements below 20°K. The anisotropic additive thermal resistivity is much greater if the temperature gradient is perpendicular to the c axis than if it is parallel. The anisotropic phonon scattering is attributed to the formation and temperature-dependent orientation of anisotropic defects. It is concluded that the defect orientation parallel to the c axis has the lowest energy, and measurements of the temperature dependence of the thermal conductivity parallel and perpendicular to the c axis give the equilibrium energy difference for reorientation to be $\approx 1.5 \times 10^{-3}$ eV. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

22214 (N-71-11415) INTRODUCTION TO EXPERIMENTAL TECHNIQUES OF HIGH-ENERGY ASTROPHYSICS. Oegelman, H.; Wayland, J. R. (eds.) (National Aeronautics and Space Administration, Washington, D. C.). 1970. 259p. (NASA-SP-243). NTIS.

Theories and experimental techniques of high-energy astrophysics are developed. Topics involve interaction of gamma rays with matter as studied by energy spectra and chemical and isotopic composition. The principles of operation of several charged particle detectors are discussed and their methods of detection, based on the process of ionization or excitation of atoms in the detection medium, are outlined. Considered are x-ray detectors, astronomical photon detectors, cosmic-ray detectors, and radio astronomical observations. (STAR)

22215 BASIC PHYSICS AND ASTROPHYSICS. Conference Held at Nice, France, April 23-26, 1969. J. Phys. (Paris), Colloq.; C3: 1-163(Nov-Dec 1969). (In French). (CONF-690449).

Twenty-two papers were presented on electromagnetic, gravitational, weak, and strong interactions in astrophysics. Separate abstracts were prepared for the twenty-two papers. (W.D.M.)

For abstracts of individual papers see: 22216, 22240-22245, 22286, 22287, 22312, 22313, 22326, 22327, 22336-22339, 22347, and 22377-22380.

Cosmic Ray Exposure Ages

Refer also to abstract 20935.

22216 STUDY OF COSMIC RADIATION BY MINERAL DETECTORS IN METEORITES. Lorin, J. C. (Laboratoire de Mineralogie du Museum, Paris). J. Phys. (Paris), Colloq.; C3: 102-10 (Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

Heavy energetic ions (Z > 22) leave in silicates stable linear trails of damage. These minerals can be used as particle detectors, and yield, in meteorites, useful indications on the radiation stored during millions of years of exposure to cosmic rays. Some main results obtained by this method on galactic cosmic rays are reviewed. Information is given about the recent report of evidence for an ancient solar irradiation in some crystals and chondrules of gas-rich meteorites. (auth)

Stars

Refer also to abstract 22771.

22217 (NP-18720) ASTROPHYSICAL INVESTIGATION OF FOUR CLASSICAL CEPHEID VARIABLE STARS. Schmidt, Edward G. (Australian National Univ., Canberra). 1969. 396p. Dep. NTIS (U. S. Sales Only).

Thesis.

The properties of the variable Cepheids γ Ophiuchi, U Sagittarii, S Normanae, and η Aquilae were examined. Study of H_α profiles indicated that they were an effective indicator providing a fast accurate method of determining temperature variation and giving agreement with photometric results, although profiles are effected by absorption in cooler Cepheids. The effect of line blocking on the B-V colors of yellow supergiants showed some difference between the blanketing of different Cepheids at the same temperature due to turbulence and gravity differences. Curves of growth and fine analyses of gravity agreed within the limitations of the methods assuming that during part of the cycle atmospheres are not in quasi-hydrostatic equilibrium. If masses are calculated on the assumption that there is hydrostatic equilibrium for the rest of the cycle, then they are in agreement with the evolutionary tracks. Iron abundances were the same to within 60%. Radii were determined from the Wesselink method, and luminosity gave reasonable agreement with the period-luminosity-color relation. There was no evidence to support the suggestion, based on pulsational models, that Cepheids are undermassive compared to evolutionary tracks, because gravities measured were in agreement with the hypothesis that masses are equal to evolutionary masses; and cluster stars in M25 and NGC 6087 are located in the H-R diagram at positions consistent with the evolutionary tracks without mass loss. Calculations with mass loss created discrepancies. Some suggestions regarding future investigations are given. (Australia)

22218 APPLICATION OF FEAUTRIER'S TECHNIQUE TO PROBLEMS IN RADIATIVE TRANSFER. Cannon, C. J. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 386-7(Sep 1970).

A method formulated by Feautrier and Auer was used to obtain solutions to the multidimensional equation of transfer for spectral line radiation in moving media. A stable set of coupled second-order differential equations is generated from the general case. (Australia)

22219 SCATTERING OF LINE RADIATION THROUGH STATES PERTURBED IN THE QUASI-STATIC LIMIT. Argyros, J. D. (Univ. of Queensland, Brisbane). Proc. Astron. Soc. Aust.; 1: 387-8(Sep 1970).

A distribution law is derived for radiative scattering events performed by an atom whose energy-level structure is perturbed under conditions appropriate to the quasi-static limit. Variation of the distribution of local ions between absorption and emission of a photon by an atom is taken into account. (Australia)

22220 NEW REDISTRIBUTION FUNCTION APPLIED TO RADIATIVE TRANSFER. Argyros, J. D. (Univ. of Queensland, Brisbane). Proc. Astron. Soc. Aust.; 1: 389-90(Sep 1970).

Simplified computation of typical source functions is presented using a different redistribution function from that of Hummer. (Australia)

22221 FORMATION OF LINE SPECTRA. A REVIEW. Jefferies, J. T. (Univ. of Hawaii, Honolulu). Proc. Astron. Soc. Aust.; 1: 356-62(Sep 1970).

Difficulties in interpreting spectral lines and relating them to model atmospheres are reviewed. An analysis of the physical state of the gas from observed radiation is made by computation from a model of specified structure (initially a two-level atom approximation, then the multi-line atom, and finally consideration of multi-dimensional problems). The model parameters are adjusted in an attempt to achieve agreement with observation. An attempt is made to apply this study to an analytical approach where general principles are applied to devise a model that permits inference of certain atmospheric properties from observations. Lack of satisfactory agreement with observational data is attributed to uncertainties in atomic data, outstanding numerical difficulties, unsatisfactory specification of atmospheric models, doubts on observational data, and unresolved questions associated with the influence of limiting the number of levels retained in the atomic model. Until the solar case is properly understood, analysis of stellar spectra will remain undetermined due to the lack of center-limb data. (44 references) (Australia)

22222 ABSOLUTE FLUX DISTRIBUTION OF SIRIUS. Davis, J.; Webb, R. J. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 378-9(Sep 1970).

The empirical absolute surface flux distribution for Sirius is compared with the predicted flux distributions for model atmospheres. No model fits the observations in both uv and visual; models including C, Mg, and Si opacities give better fits; inclusion of the empirically determined Si abundance (4 times the solar value) improves the fit slightly in the middle uv compared to the normal abundance. Possible reasons for the discrepancies are given. (Australia)

22223 THEORETICAL TREATMENT OF STELLAR CONVECTION ZONES. Unno, Wasaburo (Tokyo Univ.). Proc. Astron. Soc. Aust.; 1: 379-81(Sep 1970).

The theory of stellar convection zones in the representative eddy approximation is treated. The approximate equality of effective Reynolds and Péclet numbers agrees with previous predictions but the value of the Reynolds number, previously taken as 10, should be reduced by a factor of about 2.5. (Australia)

22224 NONLINEAR CONVECTION WITH FREE BOUNDARIES. Murphy, J. O. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 1: 381-2(Sep 1970).

The Runge-Kutta method is used for integrations of basic equations up to intermediate Rayleigh number values in an attempt to overcome instabilities in numerical methods. Calculations were extended to larger values of Rayleigh number

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making use of an iterative procedure involving quasi-linearization of the equations. It is intended to test the validity of alternative integration methods applicable to the large Rayleigh number relevant to the astrophysical case, by these methods, as well as to use them as a basis of asymptotic methods. (Australia)

22225 NONLINEAR CONVECTION AT HIGH RAYLEIGH NUMBER. van der Borght, R. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 1: 382-3(Sep 1970).

Results obtained in the case of high Rayleigh numbers using the asymptotic method are reported. For astronomical applications these hold only in a region in which the Boussinesq approximation is valid, thus restricting the thickness of the convective layer to which calculations may be applied. (Australia)

22226 PRINCIPLE OF INVARIANCE AND NONCOHERENT SCATTERING. Holt, J. N. (Univ. of Queensland, Brisbane). Proc. Astron. Soc. Aust.; 1: 383-4(Sep 1970).

An expression is presented for the reflecting properties of a semi-finite, plane parallel, isothermal atmosphere. The absorption and scattering of incident radiation is assumed to be due to transitions in two-level atoms. Absorption and emission profiles are given by frequency from line center in Doppler units. (Australia)

22227 VELOCITY-DEPENDENT SOURCE FUNCTIONS. Rees, David E. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 384-6(Sep 1970).

The effect of a velocity gradient on the source function for a spectral line formed in an atmosphere in non-LTE is considered. A numerical method is used for an isothermal plane-parallel, semi-finite atmosphere of two-level atoms. (Australia)

22228 GLOBULAR CLUSTER NGC 6352. Alcaino, G. (Cerro Tololo Inter-American Observatory, Santiago de Chile). Astron. Astrophys; 11: 7-13(Mar 1971).

A UBV photometric investigation of the previously unstudied metal-rich globular cluster NGC 6352 was carried out at the Cerro Tololo Inter-American Observatory with the 60-inch reflector. Twenty-three stars were observed photoelectrically an average of 3 times to apparent magnitude V = 15.49. With this sequence, 220 stars were calibrated photographically. A tendency of "double" giant and horizontal branches was observed. The fainter of the two "horizontal branches" was interpreted in terms of upper main-sequence stars. The apparent distance modulus $(m - M)_{app} = 14.80$. The adopted reddening was E(B-V) = 0.44. If AV = 3E(B-V), the true distance modulus is $(m - M)_0 = 13.48$. The distance is 4966 pc from the Sun and 606 pc from the galactic plane. The giant branch rises 2.0 mag above the horizontal branch at $(B-V)_0 = 1.4$, characteristic of a highly metal rich object. (auth)

22229 GLOBULAR CLUSTER NGC 1261. Alcaino, G.; Contreras, C. (Cerro Tololo Inter-American Observatory, Santiago de Chile). Astron. Astrophys; 11: 14-19(Mar 1971).

A UBV photometric investigation of the previously unstudied globular cluster NGC 1261 was carried out at the Cerro Tololo Inter-American Observatory with the 60-inch reflector. Eighteen stars were observed photoelectrically an average of 3 times to apparent magnitude V = 16.74. With this sequence, 206 stars were calibrated photographically. No reddening was detected. The true distance modulus in $(m - M)_0 = 16.1$. The distance is 16,600 pc from the Sun and 12,910 pc from the galactic plane. The very scattered giant branch rises 2.7 magnitude above horizontal branch at $(B-V)_0 = 1.4$, characteristic of a metal-poor object. (auth)

22230 LIGHT CURVE AND PHOTOMETRIC ELEMENTS OF XZ PUP. Johansen, K. T.; Joergensen, H. E.; Bohr, V. (Copenhagen Univ. Observatory). Astron. Astrophys; 11: 20-7(Mar 1971).

Based on photoelectric B and V measurements of the eclipsing binary XZ Pup photometric elements were determined. Combining the obtained results with the spectroscopic data given by Struve (1946) and his description of the spectra, the following characteristics of the system were obtained. The primary is an A0 main-sequence star with a radius equal to 3.5 $R_\odot$ and a mass about 2.6 $M_\odot$. The secondary is a G subgiant with a radius of 3.4 $R_\odot$ and a mass equal to 1.1 $M_\odot$. The radius of the secondary equals that of the corresponding Roche limit. Thus it is concluded that XZ Pup is an Algol-type eclipsing binary. (auth)

22231 STUDY OF Be STARS: THE BALMER DECREMENT. Briot, D. (Observatoire, Paris). Astron. Astrophys; 11: 57-64(Mar 1971). (In French).

Values of Balmer decrements for 55 Be stars of luminosity classes V, IV, and III, and spectral types ranging from B0 to B9 were measured from moderate dispersion spectra (100 Å/mm). From a statistical investigation of these results, the following conclusions were drawn: 1) The strength of the Balmer emission lines decreases markedly from B0 to B9. The Balmer decrement $H\alpha/H\beta$ increases, whereas $H\gamma/H\beta$, $H\delta/H\beta$, $H\epsilon/H\beta$ decrease. 2) The present data fail to indicate any significant correlation between the rotational velocity of the central star (v sin i) and the amount of emission. Various theoretical models of Be stellar atmospheres were checked. It turns out that the results rule out theories assuming a static atmosphere, but are in better agreement with Sobolev's (1947) moving-medium hypothesis. The theories of Miyamoto and Kogure and of Sobolev were applied in order to derive, from the material, some physical characteristics of the extended atmospheres of Be stars, for a given value of the central star's temperature. Values for the radii were obtained, using Doazan's (1965) and Hirata and Uesugi's (1967) solutions of the Sobolev's equations. (auth)

22232 GENERAL RELATIVISTIC SECULAR INSTABILITY OF SUPERMASSIVE STARS. Appenzeller, I.; Kippenhahn, R. (Univ., Goettingen, Ger.). Astron. Astrophys; 11: 70-8(Mar 1971).

In order to determine the secular stability of core nuclear burning, the variation of the mean temperature during homologous changes was investigated for supermassive stars. It was found that if Newtonian mechanics is assumed, the core nuclear burning in supermassive stars is always secularly stable. A repetition of the analysis using the post-Newtonian theory, however, shows that because of general relativistic effects in supermassive stars above a certain limiting mass (of about 5×10^5 $M_\odot$) the core nuclear burning becomes secularly unstable. Like in the case of the general relativistic dynamic instability, this limiting mass is increased if the star is rotating. (auth)

22233 SHORT-PERIOD VARIABLE STARS. V. DELTA SCUTI-TYPE STARS IN THE GENEVA SYSTEM. Hauck, B. (Univ., Lausanne, Switzerland, Observatoire, Geneva). Astron. Astrophys; 11: 79-82(Mar 1971).

Thirty δ Scuti-type stars were measured in the photometric system of the Geneva Observatory. From these measurements, it was possible to obtain the temperature and the absolute magnitude of this category of stars. A critical study of the meaning of the parameter Δm_2 (or Δm_1 in the uvby β system) showed that the results obtained for the δ Scuti-type stars are characteristic of the giant stars, rather than of the Am stars. This was in agreement with the study of Breger (1970) who showed that either Am characteristics tend to inhibit pulsation, or else pulsation destroys the observable Am characteristics. (auth)

22234 COMPOSITE SPECTRUM OF γ^2 VELORUM. Baschek, B.; Scholz, M. (Univ., Heidelberg). Astron. Astrophys; 11: 83-8(Mar 1971).

Equivalent widths of absorption lines of the O component of the spectroscopic binary γ^2 Vel (WC8 + O8) were measured on high-dispersion spectrograms. By comparison with seven OB spectra, the O star was classified as O8, and its visual continuum was found to be 1 to 1.8 magnitudes brighter than that of the Wolf–Rayet star. From the absolute magnitude, $M_v(\gamma^2$ Vel) = −5.6 ± 0.4, of the binary, one obtains M_v(WC8) = (−3.6 . . . −4.2) ± 0.4 for the Wolf–Rayet component. (auth)

22235 RECOVERY OF SMALL EQUIVALENT WIDTHS FROM NOISE. Foy, R. (Institut d'Astrophysique, Paris). Astron. Astrophys; 11: 89-99(Mar 1971).

A method is described for studying weak lines on high-dispersion spectra. In this method, the instrumental profile, or its analytic shape, the wavelengths of the lines, and the analytic shape of the intrinsic profiles of the lines are data of the problem. From these data, a model of the observed spectrum was computed and fitted with the observed spectrum, using a least-squares method. Lines that are very narrow with respect to the width of the instrumental profile were considered. The only unknown parameter of a line is, therefore, its central depth. With this hypothesis, a synthetically computed spectral range of Arcturus, and a 12 Å/mm spectrum of the Moon were reduced. In this way, equivalent widths of the order of 10mÅ were reached, and lines as close together as 0.15 or 0.20 Å were separated. The sources of errors were studied: noise, error in the instrumental profile, error due to the spectral density of lines (blends), error in the origin of wavelength. The case of lines with gaussian intrinsic profile was also treated. A few lines of the spectrum of the Moon were computed in this case. This work will allow the accuracy of the determination of stellar abundances to be improved. (auth)

22236 SPECTRAL VARIATIONS OF 3 Be STARS. Hubert, H. (Observatoire, Meudon, France). Astron. Astrophys; 11: 100-6 (Mar 1971). (In French).

Some preliminary qualitative results are given on three Be stars—HD 142926, HD 218393, and HD 109387—regularly observed at the Haute Provence Observatory from 1953 to 1970 with small and moderate dispersion. For each of them, variations of intensity of the envelope are noted. (a) HD 142926. From 1953 to 1963, HD 142926 presents the absorption spectrum of a normal B star. Since 1963, the first Balmer lines appear in emission and a metallic absorption spectrum is developed. According to the previous observations, the variation period is evaluated to about 30 years. (b) HD 218393. The character of the extreme variability of the spectrum of the envelope is confirmed. The period is about 37 days. The outstanding feature of the spectrum is the extreme complexity of the Ca II and H lines profiles. (c) HD 109387. From 1955 to 1970, HD 109387 presents intense Hα and Hβ lines with an emissive metallic envelope of variable intensity. The structure of the Hα emission line is extremely complex and presents multiple absorption lines (2 or 3 according to the variation phase). The variation period of this phenomenon seems to be of the order of 30 days. (auth)

22237 STATISTICAL ESTIMATES FROM PROPER MOTIONS. III. Mennessier, M. O. (Observatoire, Paris). Astron. Astrophys; 11: 111-22(Mar 1971).

In papers I and II it was established that the hypothesis of secular parallax introduces a bias on the estimates of the coordinates of the apex. A method is given to estimate this bias, if the space density and luminosity functions of the sample of stars can be approximately described. The theoretical variations are studied with the help of simplified patterns. Estimates are made in some concrete cases. Although the bias has only a relative importance in an individual estimate, it seems that the HSP can increase or diminish some phenomena that appear when several estimates are compared. (auth)

22238 POLARIZATION OF SOUTHERN OB STARS. Klare, G. (Landessternwarte Heidelberg-Koenigstuhl); Neckel, Th.; Schnur, G. Astron. Astrophys; 11: 155-8(Mar 1971).

The polarization data of southern OB stars (Klare et al., 1971) are briefly discussed. The polarization data are shown in galactic coordinates. (auth)

22239 DYNAMICS OF STAR CLUSTERS. King, Ivan R. (Univ. of California, Berkeley). Sky Telesc.; 41: 139-43(Mar 1971).

The questions of birth, evolution, and family relationships among stars in clusters are considered. Velocity distributions, observation of tidal limits, luminosity functions, and star counts are discussed. (W.D.M.)

22240 BEHAVIOR OF ELECTRONS IN A MAGNETIC FIELD OF 10^{13} GAUSS OR MORE AND ASTROPHYSICAL IMPLICATIONS. Jancovici, B. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), Colloq.; C3: 14-18(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

A few recent studies of the properties of electrons in an intense uniform static magnetic field (10^{13} Gauss or more) are reviewed. Some astrophysical mechanisms might produce such fields. The knowledge of the quantum states of a Dirac electron in the field allows a calculation of the equation of state for an electron gas when the interactions are neglected. The pressure is, of course, anisotropic. For a degenerate gas in a strong field, the pressure normal to the field can vanish, and the gas behaves like a one-dimensional one. The magnetization of the gas is computed; it is always small compared to the field, and the gas never becomes ferromagnetic. Various reactions between particles, caused either by the electromagnetic or by the weak interactions, in the presence of a magnetic field, are discussed. A study is made of how the presence of an anomalous magnetic moment for the electron can shift the energy of its ground state in a magnetic field. Other papers are refuted, and it is shown that this radiative correction to the energy remains a small one, even in very high fields. (auth)

22241 NEUTRINO EMISSION FROM STARS. Ruderman, M. A. (New York Univ., N. Y.). J. Phys. (Paris), Colloq.; C3: 56-67 (Nov-Dec 1969).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

Almost all theories of weak interactions predict that accelerated electrons will radiate neutrino pairs through a mechanism analogous to that for the emission of photons, but with greatly reduced probability. There is, in addition, some laboratory and considerable astrophysical evidence for such an interaction. Neutrino pair radiation from a star should greatly exceed that of light after the helium-burning phase of stellar evolution ($T_c \gtrsim 10^8$ °K). In a presupernova phase, neutrino emission by a single star should greatly exceed the light emission of the rest of the Galaxy. The various mechanisms for neutrino emission that dominate for different temperature–density regimes are applied to those parts of stellar evolution for which existing observation should be most sensitive to such radiation: the observed numbers of red and blue supergiants, the possible rapid contraction of planetary nebulae central stars, ultraviolet dwarfs, and the abundances of the elements around iron. None of the observations argue against the direct weak electron–neutrino coupling. Although they give no decisive evidence for it, the observations do give modest support for such a coupling. If it exists, some of the details of this coupling are better explored astrophysically than in the laboratory. (auth)

22242 CHEMICAL COMPOSITION OF STARS. Cayrel, R. (Institute National d'Astronomic et de Geophysique, Meudon, France). J. Phys. (Paris), Colloq.; C3: 126-31(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

The methods used to transform the observational data into chemical composition of stellar atmospheres are described. This transformation needs, in most cases, the use of a physical working assumption, called the hypothesis of local thermodynamic equilibrium. Some insight is given of the difficulties met when one tries to use a more general theory of line formation. A few results of special significance in the field of the nuclear composition of stars are given. (auth)

22243 PROPERTIES OF NUCLEI AND COSMIC ABUNDANCE OF ELEMENTS. Reeves, Hubert (SEP Saclay, France. IAP, Paris. Univ. of Montreal). J. Phys. (Paris), Colloq.; C3: 132-6(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

Certain properties of the nuclear forces are reflected in the cosmic abundance curve. From the theory of stellar nucleosynthesis one can understand how these properties have shaped the cosmic abundance curve. (auth)

22244 NUCLEOSYNTHESIS AND LABORATORY EXPERIMENTS. Gradsztajn, Eli. (CNRSI, Orsay, France). J. Phys. (Paris), Colloq.; C3: 137-43(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

The knowledge of the Li, Be, and B isotopic production is of great importance in the understanding of the origin of these rare elements in nature. Some relevant experimental results on the spallation of CNO at high energy (from a few MeV to GeV protons) are reviewed. The application of these results to astrophysics is discussed, as well as the observational data on the Li, Be, and B isotopes obtained from the surface of stars, the Earth and meteorites, and galactic cosmic rays. (auth)

22245 SUPERDENSE MATTER IN STARS. Ruderman, M. (New York Univ., N. Y.). J. Phys. (Paris), Colloq.; C3: 152-60 (Nov-Dec 1969).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

After the nuclear evolution of stellar cores has ended stars rapidly approach their final superdense state. The regime of central densities encompassed in such objects extends from 10^5 g cm^{-3} in the lighter white dwarfs, to 10^{15} g cm^{-3} and more, in canonical neutron stars, or stars indefinitely collapsing toward their Schwarzschild surface. Such dense matter generally consists of a highly degenerate (relativistic) electron sea in which are imbedded conventional nuclei for white dwarfs, and mainly neutrons (or hyperons) with a small proton and electron component in the center of typical neutron stars. The very high momentum of the degenerate electrons so greatly reduces their dielectric polarizability that protons, neutrons and nuclei move in an essentially uniform background sea. Such matter has calculable properties for very dense stars: some white dwarfs will be crystalline. The heavier (smaller) ones will have a T^3 Debye heat capacity and will consequently cool rapidly as is suggested by observations. The outer regions of a neutron star will also be crystalline since the melting temperature exceeds 3×10^8 °K. Below the solid mantle the neutrons and protons form quantum superfluids with a BCS type gap of order one MeV. The gap is isotropic below nuclear densities and probably anisotropic above. In the center where the density can exceed that within a nucleus the pressure is no longer negligible next to the total relativistic

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energy density, and the nature of such matter is very uncertain. Some fundamental aspects of this regime are discussed. (auth)

22246 MEASUREMENTS OF HYDROGEN LINES IN B STARS BY A METHOD OF PHOTOGRAPHIC NARROW-BAND PHOTOMETRY. Furenlid, Ingemar (Stockholm Observatory). Astron. Astrophys.; 10: 321-31(Feb 1971).

A new method of photographic narrow-band photometry was applied to the measurement of the hydrogen lines Hγ and Hδ in the spectra of a number of B stars. The method, which is based on the same principle as the photoelectric Hβ photometry of Strömgren and Crawford, yields indices of hydrogen line strength of high accuracy. The principal index of the mean strength Hγ and Hδ, called I(30,120), has a total range of approximately 0.400 magnitudes and a rms error of around ±0.007 magnitudes. An analytical expression for the rms error caused by plate graininess is derived and the principles of photographic filter photometry discussed. (auth)

22247 Ap Si 4200 STARS: EFFECTIVE TEMPERATURES AND SUPERFICIAL GRAVITIES. Megessier, C. (Observatoire, Paris). Astron. Astrophys.; 10: 332-41(Feb 1971). (In French).

18 Ap Si 4200 stars were studied. The effective temperatures were determined from wide and narrow band color indices and also from the intensity ratio of the Si III and Si II lines. It was concluded that the best way to determine the parameter θ_e for these stars is to use a calibration giving θ_e as a function of (U − B) or (u − b) color indices, after having taken into account their variability and their location in the (U − B)/(B − V) diagram. It was found that Ap Si 4200 stars with strong Si II lines have effective temperatures between $0.30 \leqq \theta_e \leqq 0.40$. The surface gravities were determined from the Hγ, Hδ Balmer lines profiles from ESW's theory, which has been found to be the best one as had been predicted by Peterson. The stars have the same gravity as normal stars. As far as silicon abundance is concerned, there is no clear-cut separation between Ap Si stars and normal stars. There is in fact a smooth transition from the silicon abundance of normal stars to those of Ap Si 4200 stars. (auth)

22248 INFLUENCE OF AXIAL STELLAR ROTATION ON AGE ESTIMATES OF OPEN STAR CLUSTERS. Maeder, A. (Observatoire, Geneva). Astron. Astrophys.; 10: 354-61(Feb 1971).

In the case of uniform rotation, the effects on the internal stellar evolution are shown to be negligible for the age estimates in comparison with the atmospheric effects. An individual rotational correction is applied to the color index of the stars situated in the turnoff region of the cluster. As this correction depends only on the value of the product $v_R \cdot \sin i$, the orientation of the axes of rotation with regard to the observer fortunately does not intervene. The ages of seven clusters, in which the values of $v_R \cdot \sin i$ are known, are estimated with and without rotational corrections by fitting with isochronic lines from nonrotating models. It is found that without these corrections the ages of the Pleiades and αPersei clusters are overestimated by about 60 to 70%. For the Hyades, Praesepe, and Coma clusters, the difference is small and amounts to 10%. Some important deviations to the sequence in the color−magnitude diagram are well explained by rotation, and the turnoff of some clusters appears more clearly defined after correction. (auth)

22249 ALPHA-CAPTURING REACTIONS IN ^{20}Ne, ^{24}Mg, ^{28}Si AT HIGH TEMPERATURES. Duorah, K.; Duorah, H. L. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 10: 377-82(Feb 1971).

Resonance contributions to the alpha-capturing reactions in ^{20}Ne, ^{24}Mg, and ^{28}Si at high temperatures were examined with new experimental data. It is suggested that the optical model calculation in the temperature range considered is definitely an overestimate when compared with the sum-over resonance rates, though it is not very bad in the case of $^{24}Mg(\alpha,\gamma)\,^{28}Si$ in the range $0.8 \leqq T_9 \leqq 1.2$. The possible importance of resonances outside of the measured range for each T_9 was examined quantitatively. These calculations are expected to be relevant in conditions found in the collapse stage of stellar evolution. (auth)

22250 ATMOSPHERE OF THE A0 Ib SUPERGIANT η LEONIS. Wolf, B. (Univ., Munich). Astron. Astrophys.; 10: 383-400(Feb 1971).

The equivalent widths of 560 lines in the wavelength interval $3150 < \lambda < 6565$Å were measured, and a coarse analysis was made to get the initial parameters for the succeeding fine analysis. The observations are best fitted by a model atmosphere (radiative equilibrium, LTE, no line blanketing) with the parameters $\log g = 2.05 \pm 0.20$ and $T_e = 10400° \pm 300°$K, and a microturbulence varying with the optical depth from 2 km/s at $\bar{\tau} = 1.3$ to 10 km/s in the outermost layers. The relative temperature distribution in the final model is the same as that of a Mihalas model with the same parameters log g and T_e; but Mihalas' method would give a value of T_e that is greater by 200°K. The computed continuum agrees well with the photoelectric measurements of Schild and Oke. The computed color indices in the UBV system are $(U-B)_{cal} = -0.23$[$(U-B)_{obs} = -0.25$] and $(B-V)_{cal} = -0.08$ [$(B-V)_{obs} = -0.04$]. The bolometric correction is 0.41. The profiles of the metallic lines of η Leo show a macrobroadening of about 15 km/s. The same iron abundance from the Fe I and Fe II lines can be obtained only if the new Fe I oscillator strengths of Garz and Kock are used. The large helium abundance computed from the He lines that originate in the 2^3P and 2^1S terms is the result of an overpopulation of these levels because of departures from thermodynamic equilibrium; this can be explained by a chromospheric shell. The average metal abundance is somewhat larger than the mean value for the Sun [$\log \epsilon - \log \epsilon_\odot \approx 0.25$). The luminosity was computed as $L/L_\odot \approx 15{,}000$, the radius as $R/R_\odot \approx 40$, and the mass as $M/M_\odot \approx 9$. (auth)

22251 DYNAMICAL STRUCTURE OF THE h AND χ PER ASSOCIATION. Gahm, G. F.; Arkling, J. G. (Stockholm Observatory). Astron. Astrophys.; 10: 414-20(Feb 1971).

New radial velocities for the red supergiants surrounding h and χ Per were obtained from spectrograms at a dispersion of 16 Å/mm. These velocities together with those obtained by others for additional red and blue supergiants in the region indicate the presence of a certain velocity pattern in the association. The most negative velocities are found in a region centered about 0.5 degrees north of χ Per, and those most positive in the outermost region. A mean velocity difference of 4.7 km/s is found between Schild's inner and outer groups. The question of membership of dubious members is discussed on basis of radial velocities. One star, HD 17306, is found to vary in radial velocity, possibly because of binary motion. (auth)

22252 TEMPERATURE AND DENSITY IN GASEOUS NEBULAE. Perinotto, M. (Univ. of California, Los Angeles). Astron. Astrophys.; 10: 421-33(Feb 1971).

The equations of statistical equilibrium for the five-level atom were solved exactly for several ions of the series $2p^q, 3p^q (q = 2, 3, 4)$ and results are presented for the ions: N II, O III, Ne III, Ne V, Na IV, S III, Cl II, Cl IV, Ar III, Ar V, K IV, and Ca V. The computations were applied to the fairly regular, highly stratified planetary nebula NGC 7662 to investigate whether the derived temperature and density conditions in the regions where the different radiations originate can be made consistent with theoretical models of the nebula. Almost all the forbidden emission line intensity ratios sensitive to the electron temperature and/or density so far measured in NGC 7662 were used. An agreement with the detailed ionization stratification models developed for NGC 7662 or with the general typical model of a planetary nebula was not clearly achieved. Indications were found that probably some large inaccuracy still exists in the atomic data for specific ions. However, for a better understanding of the actual accuracy of each theoretical ratio of forbidden emission line intensities, improved observations with the largest spatial resolution as well as a closer knowledge of their accuracy for each ratio would be quite useful. On the other hand, realistic theoretical models of planetary nebulae probably must take into account the specific structures and inhomogeneities of the nebular gases. (auth)

22253 DETERMINATION OF EFFECTIVE TEMPERATURES FROM LINE RATIOS. Stickland, D. J. (Royal Greenwich Observatory, Herstmonceux, Sussex, Eng.). Astron. Astrophys.; 10: 478-80(Feb 1971).

The determination of effective temperatures from ratios of equivalent widths of iron lines is discussed and an empirical calibration for six ratios is presented for normal and mildly abnormal stars of luminosity class V in the spectral range A0 to G2. (auth)

22254 STRUCTURE OF RELATIVISTIC DISKS. Salpeter, Edwin E.; Wagoner, Robert V. (Cornell Univ., Ithaca, N. Y.). Astrophys. J.; 164: 557-67(15 Mar 1971).

The effects of pressure on the structure of uniformly rotating relativistic thin disks are investigated. Some properties of zero-temperature stars and disks are compared; in particular, formulae are given for the thickness and binding-energy correction of the disks (which could also be applied to differentially rotating disks), and the relevance to pulsar models is discussed. The properties of supermassive disks and stars are also compared; in particular, long lifetimes and high temperatures are possible in the disk phase, and the relevance to "rotator" models for QSOs is discussed briefly. (auth)

22255 ADVANCED EVOLUTION OF POPULATION II STARS. II. THE HORIZONTAL BRANCH. Demarque, Pierre; Mengel, John G. (Yale Univ., New Haven). Astrophys. J.; 164: 469-73(15 Mar 1971).

Evolutionary tracks for post-helium-flash and horizontal-branch evolution are presented for masses 0.85, 0.60, 0.559, and 0.502 $M_\odot$. The surface chemical composition is (X,Z) = (0.733, 0.001) corresponding to (X,Z) = (0.75, 0.001) on the main sequence. Comparison with Newell's study of blue horizontal-branch stars yields agreement with his Group A for 0.60 $M_\odot$. The very blue stars in Newell's Groups B and C, so far unexplained, are seen to have masses ranging from 0.50 to 0.56 $M_\odot$. Mass loss and other less likely explanations of the low masses found are briefly discussed. (auth)

22256 EVOLUTION OF LOW-MASS STARS. III. EFFECTS OF NONIDEAL THERMODYNAMIC PROPERTIES DURING THE PRE-MAIN-SEQUENCE CONTRACTION. Grossman, A. S. (Iowa State Univ., Ames); Graboske, H. C. Jr. Astrophys. J.; 164: 475-90(15 Mar 1971).

A generalized statistical-mechanical approach that utilizes a procedure of free-energy minimization was used to compute the nonideal thermodynamic-equilibrium properties for the temperature–density regime applicable to low-mass stars. Pre-main-sequence evolutionary tracks were computed for stars in the mass range 0.03 to 0.20 $M_\odot$, for a composition with X = 0.68, Y = 0.29, Z = 0.03. The theoretical $l/H_p = 1$ for the hydrogen main sequence was determined, and it was found that a 0.08 $M_\odot$ star will no longer reach a stable main-sequence phase, whereas a 0.09 $M_\odot$ star does achieve stability in 1.6×10^9 years. Therefore, the main-sequence mass limit at this composition is between 0.08 and 0.09 $M_\odot$. The major effect of the new thermodynamic properties is to shift the theoretical main sequence toward higher effective temperatures and higher luminosities. For an initial deuterium abundance $X_D = 0.19 \times 10^{-3}$, and an l/H_p ratio of 1, the duration of the deuterium main sequence varies from 2.4×10^6 years at 0.2 $M_\odot$ to 2.1×10^7 years at 0.03 $M_\odot$. An analysis of the various interaction effects in the model of dense, multicomponent gases indicates that the bound-state perturbations and the Coulomb interactions are dominant nonideal effects. These effects are large at all times for stars in the mass range $0.03 \leq M/M_\odot \leq 0.20$, and extend from the center to the outer envelope. (auth)

22257 LOOP SIZES IN THE HERTZSPRUNG–RUSSELL DIAGRAM DURING CORE HELIUM BURNING. Robertson, J. W. (Australian National Univ., Canberra). Astrophys. J.; 164: L105-7(15 Mar 1971).

The loop length at the core-helium-burning stage of 5 $M_\odot$ evolution is extremely sensitive to the abundance profile in the shell-hydrogen-burning region, as left behind by the shrinking main-sequence convective core. (auth)

22258 RANDOM GRAVITATIONAL ENCOUNTERS AND THE EVOLUTION OF SPHERICAL SYSTEMS. I. METHOD. Spitzer, Lyman Jr.; Hart, Michael (Princeton Univ., N. J.). Astrophys. J.; 164: 399-409(15 Mar 1971).

A modified Monte Carlo method is described for following the dynamical evolution of a spherical stellar system. In this method, designed for use with a digital computer, the trajectory of each star is computed numerically through time on the assumption that the gravitational potential is spherically symmetric. This procedure, used earlier by Campbell and Hénon, becomes exact if each star is taken to represent a spherically symmetric shell composed of many stars, all characterized by the same values of the mass, of the distance r from the center, of the radial velocity v_r, and of the transverse velocity v_t; however, the orientation of the orbital planes is assumed to be random for the stars at each location in the shell. To take into account irregular variations in the gravitational field, produced by encounters with passing stars, the velocity of each star is perturbed at intervals of time $(\Delta t)_p$. The perturbations are chosen to give the appropriate diffusion coefficients for stars within each small range in r. To expedite the computations, the diffusion coefficients are simplified, with $\langle(\Delta v_\parallel)\rangle/v$ taken to be constant, with $\langle(\Delta v_\perp)^2\rangle$ set equal to $2\langle(\Delta v_\parallel)^2\rangle$ and also assumed constant, and with these constant values set equal to the exact values of these coefficients for v^2 equal to the mean square velocity. In the case of an isotropic velocity distribution in which all velocities are initially equal, this method of computing the effect of gravitational encounters is shown to be in satisfactory agreement with a full numerical solution of the Fokker–Planck equation. For reliable results, $(\Delta t)_p$ must not exceed about one-fifth of the relaxation time. (auth)

22259 LIGHT FROM REFLECTION NEBULAE. IV. SCATTERING BY SILICATE GRAINS. Hanner, Martha S. (Dudley Observatory, Albany). Astrophys. J.; 164: 425-35(15 Mar 1971).

Models of the UBV colors and polarization in reflection nebulae are presented, based on Mie scattering functions for an exponential size distribution of silicate particles, $a_0 = 0.25\ \mu$. Single scattering within a homogeneous, plane-parallel nebula is assumed. The computed nebular colors are bluer than the star color, except at large offset angles. Negative polarization is present for models with the star in front of the nebula. No theoretical model could be found which would match the observed wide range in color across the Merope nebulosity. (auth)

22260 RADIAL VELOCITY VARIATION OF EPSILON CEPHEI. Gray, David F. (Univ. of Western Ontario, London). Publ. Astron. Soc. Pac.; 83: 103-4(Feb 1971).

The radial velocity variation of ϵ Cephei was measured on three nights and found to have a variable amplitude. A beat phenomenon is a likely explanation. (auth)

22261 DISCOVERIES ON SOUTHERN OBJECTIVE-PRISM PLATES. II. NEW PROBABLE FIELD HORIZONTAL-BRANCH STARS. MacConnel, D. J. (Univ. of Michigan, Ann Arbor); Frye, R. L.; Bidelman, W. P.; Bond, Howard E. Publ. Astron. Soc. Pac.; 83: 98-100(Feb 1971).

Ten relatively bright field stars are listed that have spectral characteristics similar to those of some known blue horizontal-branch stars. (auth)

22262 DETECTION OF T TAURI-LIKE SPECTRA IN SIX STARS IN ORION. Sanduleak, N. (Case Western Reserve Univ., Cleveland). Publ. Astron. Soc. Pac.; 83: 95-7(Feb 1971).

Six faint stars near the Orion nebula, not previously confirmed to be T Tauri stars, were found to show T Tauri-type emission-line spectra on low-dispersion objective-prism plates. (auth)

22263 SPECTRAL CHANGES IN V CASSIOPEIAE. Wyckoff, S. W.; Wehinger, P. (Univ. of Kansas, Lawrence). Publ. Astron. Soc. Pac.; 83: 89-90(Feb 1971).

Nine low-dispersion near-infrared spectrograms of the Mira-type variable V Cas were obtained with several telescopes during the past four years. The dates of observation, magnitude estimates for those dates, and spectral types are given along with the near-infrared spectra near minimum and maximum light. (W.D.M.)

22264 SHORT-PERIOD VARIABLE IN THE GALACTIC CLUSTER NGC 7789. Danziger, I. J. (Harvard Coll. Observatory, Cambridge, Mass.). Publ. Astron. Soc. Pac.; 83: 84-6 (Feb 1971).

Results are reported from a study of possible candidates for short-period variability in the open cluster NGC 7789. The star 573 has the characteristics of a δ Scuti star. The period is approximately four hours; the amplitude is approximately 0.1 m. An absolute magnitude of +1.5 in M_v was obtained by using the distance modulus of 11.36 m and the reddening excess E(B − V) = 0.28 m. (W.D.M.)

22265 TEMPERATURE AND LUMINOSITY OF THE WHITE DWARF BD + 16°516B. Hills, J. G. (Univ. of Michigan, Ann Arbor). Publ. Astron. Soc. Pac.; 83: 81-3(Feb 1971).

From the amount by which it heats its K0 V binary companion the white dwarf of BD + 16°516 was calculated to have a temperature of $(64 \pm 19) \times 10^3$°K and a luminosity of $(2.2^{+1.0}_{-0.7})$ $L_\odot$. Among known white dwarfs it is currently the hottest, most luminous, and the youngest with a cooling age of about 10^7 years. (auth)

22266 OBSERVATIONS OF EMISSION-LINE STARS IN THE NEAR INFRARED. Wallerstein, George (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac.; 83: 77-8(Feb 1971).

Wavelengths of near-infrared emission lines of H, O I, Ca II, and Fe II were measured in four T Tauri-type stars and one peculiar binary. A possible correlation between emission line width and the presence of λ7772 of O I was noted and is discussed in terms of the width of Lβ which probably excites the O I by florescence. (auth)

22267 UBV PHOTOMETRY OF ECLIPSING BINARIES WITH VISUAL COMPANIONS. Hall, Douglas S.; Weedman, Samuel L. (Vanderbilt Univ., Nashville). Publ. Astron. Soc. Pac.; 83: 69-76(Feb 1971).

Nineteen eclipsing binaries with visual companions were observed photoelectrically. Comparison stars were chosen, one for each eclipsing binary and its companion, and tied into the UBV system. Then differential UBV magnitudes, relative to these comparison stars, were obtained for the binary, companion, and/or binary-plus-companion. (auth)

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22268 SCANNER OBSERVATIONS OF NOVA AQUILAE 1970. Grenfell, Thomas C. (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac.; 83: 66-8(Feb 1971).

Scanner observations of Nova Aql 1970 near maximum light indicate an unusual spectral energy distribution which is not explained by normal stellar atmosphere theory. (auth)

22269 REDDENING OF Z ANDROMEDAE FROM THE Fe II PERMITTED LINES. Caputo, Filippina (Laboratorio di Astrofisica, Frascati, Italy). Publ. Astron. Soc. Pac.; 83: 62-5(Feb 1971).

From the comparison of the Fe II permitted lines at different wavelengths in the spectrum of Z Andromedae, a color excess $E_{B-V} = 0.64 \pm 0.20$ m was derived. The same color excess was found from analysis of the Fe II forbidden lines. From the curve of growth of the Fe II emission lines the self absorption was found to be negligible. (auth)

22270 SPECTRAL-TYPE INDICATOR FOR M GIANTS AND SUPERGIANTS AT λ7125. Wawrukiewicz, Anthony S. (Univ. of Rochester, N. Y.). Publ. Astron. Soc. Pac.; 83: 57-61(Feb 1971).

A narrow-bandwidth photometric system for measuring the spectral types of M giants and supergiants was developed. The system measures the spectral region at λ7125, a region which is part of the λ7050 band system of TiO. Twenty-one MK giants and six h and χ Persei M supergiants define the system with an apparent, but slight, luminosity dependence noted. Application of the system was made to 17 M giants and 49 M supergiants. Most of these stars belong to the Warner and Swasey Observatory lists of suspected M supergiants. (auth)

22271 FAINT SUPERNOVA IN AN ANONYMOUS GALAXY. van den Bergh, Sidney (Univ. of Toronto). Publ. Astron. Soc. Pac.; 83: 56(Feb 1971).

A faint supernova was found with the 126-cm Palomar Schmidt telescope in an 18th magnitude galaxy of uncertain type that is located at α = 0h 58.7 m, $\delta = +2°21'$ (1855). A designation of 1969 o was assigned. (W.D.M.)

22272 INTERMEDIATE-AGE GALACTIC CLUSTER NGC 2660. Hartwick, F. D. A. (Univ. of Victoria, B. C.); Hesser, James E. Publ. Astron. Soc. Pac.; 83: 53-5(Feb 1971).

A provisional color–magnitude diagram based on photoelectric and photographic photometry to V ~ 16 is presented for NGC 2660. The cluster is found to be of intermediate age and its C–M diagram is very similar to that of NGC 2477. A carbon star which falls within I′ of the cluster center has, if it is a cluster member, $M_V \simeq -1.1 \pm 0.2$. (auth)

22273 VW ERIDANI: A HIGH-VELOCITY SRd VARIABLE STAR. Preston, George W. (Carnegie Institutions of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 83: 52(Feb 1971).

Spectroscopic observations show that VW Eridani is a weak-lined, high-velocity variable star of the SRd class, similar to SX Herculis. (auth)

22274 UBV PHOTOMETRY OF THE SOUTHERN CEPHEIDS l CARINAE, AG CRUCIS, AND ST PUPPIS. Landolt, Arlo U. (Louisiana State Univ. Observatory, Baton Rouge). Publ. Astron. Soc. Pac.; 83: 43-7(Feb 1971).

Recent UBV photoelectric observations of the southern cepheids l Car, AG Cru, and ST Pup are discussed. New light elements are given for AG Cru and ST Pup. (auth)

22275 TRANSITION STAGE SPECTRUM OF NOVA SERPENTIS 1970. Grygar, J. (Dominion Astrophysical Observatory, Victoria, B. C.); Smolinski, J.; Hutchings, J. B. Publ. Astron. Soc. Pac.; 83: 15-22(Feb 1971).

Four blue spectrograms, dispersion 15 Å/mm, were obtained in the advanced transition phase of Nova Serpentis 1970 7m below maximum light. The identifications and radial velocities for the emission peaks and samples of intensity tracings around Hβ and Hγ are presented. The lines display saddle-shaped profiles, with the blue emission components generally much stronger than the red ones. The velocity separation of both peaks remains constant (~918 km/s) while the whole structure of the lines was apparently shifted to the red some 50 km/s between JD 2440730 and JD 2440751. In the same time the [O III] lines became the most prominent features in the blue spectrum. (auth)

22276 UBV OBSERVATIONS OF NOVA SCUTI 1970. Warren, Wayne H. Jr. (Indiana Univ., Bloomington). Publ. Astron. Soc. Pac.; 83: 14(Feb 1971).

UBV observations of Nova Scuti 1970 made between Aug. 7 and Aug. 27, 1970 with the 16-inch reflecting telescope at the Morgan–Monroe station of the Goethe Link Observatory are reported. (W.D.M.)

22277 LOW-DISPERSION SPECTRA OF NOVA SERPENTIS 1970. Andersen, Per H.; Borra, Ermanno F.; Dubas, Orest V. (Univ. of Western Ontario, London). Publ. Astron. Soc. Pac.; 83: 5-13(Feb 1971).

A discussion of the spectral development of Nova Serpentis 1970 is given from the early decline to the nebular stage. The spectral changes are correlated with the light curve. Velocities are given for the absorption systems during the early decline from 40 and 60 Å/mm plates, while plates at 320 Å/mm were used only for discussing spectral changes qualitatively. (auth)

22278 ROTATION OF VISCOUS POLYTROPES. Marks, Dennis William. Ann Arbor, Mich.; Univ. of Michigan (1970). 58p. University Microfilms Order No. 71-4672.

Thesis.

The rotation law for stars has been an open theoretical question for some time. The customary procedure has been to drop all terms involving the viscosity in the equations of stellar structure on the ground that the viscosity is small. Poincare showed that in the absence of viscosity the condition of hydrostatic equilibrium for fluids in which the pressure is a function of density alone required that surfaces of constant rotation be cylindrical. The procedure of finding the behavior of slightly viscid fluids by ignoring the viscosity altogether is objectionable because the viscous terms contain the highest spatial derivatives and dropping those terms changes the order of the governing differential equations. Schwarzschild has shown that if viscosity is included then the condition of hydrostatic equilibrium for fluids in which the pressure is a function of density alone requires the rotation to be uniform. The consequences to a polytrope of violating Schwarzschild's theorem are examined here. (TSS) (Diss. Abstr. Int., B)

Quasi-Stellar, Radio, and X-Ray Sources

22279 (N-71-10610) X-RAY ASTRONOMY. I. Holt, Stephen S. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sep 1970. 38p. (NASA-TM-X-65372; X-661-70-379). NTIS.

Justification is presented for the theory that observable x-ray emission of high-energy photons of extrasolar origin are associated with scale sizes ranging from neutron stars to the entire intergalactic medium. The x-ray band of the electromagnetic spectrum is defined from about 0.1 keV to some few hundred keV. All photons in this energy window are thus classified as x-rays regardless of the mechanism of their origin. With the upper end of this window below the electron rest mass, it is reasonably certain that nuclear processes play no substantial role in the genesis of celestial x-rays. (auth) (STAR)

22280 (N-71-10769) SEARCH FOR TEMPORAL STRUCTURE IN X RAYS FROM Sco X-1. Boldt, E. A.; Holt, S. S.; Serlemitsos, P. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct 1970. 16p. (NASA-TM-X-65377; X-661-70-396). NTIS.

The temporal behavior was investigated of the x-ray emission from Sco X-1 on March 3, 1969, based upon data obtained over a continuous 122 sec. exposure in the energy range 2 to 20 keV, where the count was recorded each 322 μsec. No evidence was found for any temporal structure in the data. The 5 sigma upper limits on the pulsed fraction at any given period are below 1% for periods in the range 3 to 300 msec. Upper limits were established for nonperiodic variations over times from a fraction of a msec. to about 1 minute. Any continuous x-ray flickering on the scale of seconds is less than 1.2% which is below the 0.02 mag. flickering level previously observed in the visible. (auth) (STAR)

22281 INTERPRETATION OF THE PULSAR DISPERSION MEASURE. Grewing, Michael; Walmsley, Malcolm (Max-Planck-Institut fuer Radioastronomie, Bonn. Institut fuer Astrophysik und Extraterrestrische Forschung, Bonn). Astron. Astrophys; 11: 65-9(Mar 1971).

From a new list of OB stars estimates were made of the contribution to the pulsar dispersion measure due to H II regions intersected by the line of sight towards these objects. If the density in the neighborhood of early-type B stars is of the order of 1 cm^{-3}, a large portion of the pulsar dispersion measures could be explained in this way. (auth)

22282 HEATING OF H I REGIONS BY HARD UV RADIATION: PHYSICAL STATE OF THE INTERSTELLAR MATTER. Bergeron, J.; Souffrin, S. (Institut d'Astrophysique, Paris). Astron. Astrophys; 11: 40-52(Mar 1971).

The hard-uv and soft x-ray heating of interstellar H I regions is considered. The physical state of interstellar matter is studied in great detail by a computation of n_e, n_{HI}, n_{HeI} the electron, neutral hydrogen, and neutral helium densities and temperatures. Coupled ionization (H and He) and energy balance equations are solved, taking into account collisional ionization by all secondary electrons produced per photoionization. The energy spectrum of the secondary electrons is derived as a solution of the Boltzmann equation. The solutions include the possibility of two thermally stable phases in pressure equilibrium interpreted as cloud and intercloud media. Lower temperatures (<5000°K) of the rarefied phase could be reached than in the case of energetic-particle heating. The average of n_e and n_e/n_{HI} on the line of sight are, respectively, $\sim 10^{-2}$ cm^{-3} and 10^{-2} and these values are compatible with the observations. In the intercloud medium the degree of ionization of helium is much larger than for hydrogen, and this is still true in the cloud for uv energy $\lesssim$130 eV. For decreasing uv energy the intermediate unstable phase tends to disappear, since the pressure gap between the two stable phases tends to vanish; consequently, the range of densities and temperatures covered in the case of homogeneous uv radiation heating decreases with uv energy. A good fit to the observed densities and temperatures is obtained for a total photoionization rate $\sim 4 \times 10^{-16}$ s^{-1}. This leads to a radiated power in the whole interstellar space of order of 10^{41} erg s^{-1} for hard-uv sources of temperatures ~200 eV. (auth)

22283 IDENTIFICATION OF 24 RADIO SOURCES. Veron, M. P. (Observatoire, Meudon, France). Astron. Astrophys; 11: 1-6(Mar 1971).

A systematic radiosource identification program was undertaken on the basis of the catalogue of Witzel and Véron (1970). Twenty-four new identifications are proposed: 11 galaxies, 12 QSS, and one H II region. It is also pointed out that 6 radio sources, identified with galaxies, have flat or curved spectra. (auth)

22284 DISTANCES TO X-RAY SOURCES AS DERIVED FROM X-RAY INTERSTELLAR ABSORPTION AND 21-cm EMISSION OBSERVATIONS. Ilovaisky, S. A. (Institut d'Astrophysique, Paris. CEN, Saclay, France). Astron. Astrophys; 11: 134-41 (Mar 1971).

Available 21-cm emission observations in the directions to x-ray sources yield the total amount of neutral hydrogen in the line of sight up to the edge of the gas layer. Absorption effects in the spectra of eighteen galactic x-ray sources are interpreted as interstellar absorption and thus determine the amount of foreground gas. Using a realistic barometric model for the neutral hydrogen distribution, the ratio of absorption to emission column densities, $\langle N_H \rangle_X^{ab} / \langle N_H \rangle_{21}^{em}$, for a given source, is then a measure of its distance. As a result of this approach, Scorpius–Sagittarius type sources seem to be located outside the gas layer and thus only lower limits for their distances can be set. Radio and optical distances for supernova remnants are used to determine mean line-of-sight values for the interstellar neutral hydrogen density. Unidentified x-ray sources with relatively flat spectra are also discussed. The implications of these results as regards energy output and optical identification are briefly dealt upon. (auth)

22285 IDENTIFICATION AND PHOTOMETRY OF RADIO-SOURCES OF THE REVISED 3C CATALOGUE. I. Wlerick, G.; Lelievre, G.; Veron, P. (Observatoire, Meudon, France). Astron. Astrophys; 11: 142-53(Mar 1971). (In French).

The electron camera and the 1.93-m telescope of the Haute Provence Observatory were used to study a sample of sources of the revised 3C Catalogue that have a faint optical counterpart. Eight identifications are suggested or confirmed. It was also possible to measure on the electronic photographs the flux of all the objects in a given field by using at least one standard star: this property was applied to the photometry in the range $20 < B < 22$ and, in the experimental condition used it could be extended up to, at least, $B \cong 23$. Two sources, 3C 14 and 3C 42, are likely radio galaxies, while three objects, 3C 49, 3C 173, and 3C 190 are probably quasars. For three other sources, 3C 194, 3C 208.1, and 3C 460, a classification cannot be suggested. One plate yields, for the blue magnitude of 3C 190: $B = 21.25 \pm 0.20$ (the error is due mainly to the fact that the plate is underexposed). Flux of 3C 173 was measured that is rather close (10″) of a 12.6 magnitude star; 3C 173 is blue ($B - V < 0$) and variable: two plates taken at five months interval give respectively: $B = 20.00 \pm 0.15$ and $B = 21.02 \pm 0.15$. (auth)

22286 PULSARS AND POST-OUTBURST ACTIVITY IN SUPERNOVAE REMNANTS. Pacini, F. (Laboratorio di Astrofisica, Frascati, Italy). J. Phys. (Paris), Colloq.; C3: 144-51 (Nov-Dec 1969).

From Conference on fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

The main observational results concerning pulsars are reviewed. The observed range of periods and the period increase point toward an interpretation based on the rotation of a neutron star. Theoretical aspects concerning pulsars and the activity in supernova remnants are also reviewed. (auth)

22287 REMARKS ABOUT PULSARS. Cocconi, G. (CERN, Geneva). J. Phys. (Paris), Colloq.; C3: 161-2(Nov-Dec 1969).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

Observed features of the pulsars are used to obtain some information about (a) their age, (b) the spectral shape of the long-period pulsar, and (c) the frequency of "pulsarquakes." (auth)

22288 INVESTIGATION OF THE RADIO EMISSION FROM CRAB NEBULA AND SOME QUASARS AT THE WAVELENGTHS 8.2 mm AND 3.36 cm. Kostenko, V. I.; Matveenko, L. I. (Moscow Inst. of Physics). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 13: 1467-73(1970). (In Russian).

Measurements were made of the radio brightness distribution of the Crab Nebula at the wavelength 8.2 mm. During the period 1968–69 the flux densities of the radio emission from the sources 3C 84, 3C 273, 3C 279, and NRAO 150 were measured at 8.2 mm and 3.36 cm. The density variations in time were considered and spectral indices were determined. (auth)

22289 RADIATION STABILITY OF THE DISCRETE SOURCE CASSIOPEIA-A IN DECAMETER WAVE RANGE. Benediktov, E. A. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 13: 1474-9(1970). (In Russian).

During the period 1963–1968 regular measurements were carried out on the relation of the intensity of the radio emission from Cassiopeia-A to the background level of the distributed cosmic radio emission at the frequency 13 Mc. The observations showed the absence of considerable intensity variations of the source with the characteristic time of the order of several months. The annual decrease of the source intensity was not detected. (auth)

22290 GALACTIC AND METAGALACTIC COMPONENTS OF DISTRIBUTED COSMIC RADIO EMISSION. Getmantsev, G. G.; Pyatova, E. D.; Tokarev, Yu. V.; Shibaev, V. A. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 13: 1480-5(1970). (In Russian).

According to previous experimental data it was shown that with departure from the galactic plane along the declination circle $\delta = +56°$, the spectral index of the galactic radio emission β_{gal} at the frequency 40 Mc smoothly increases from $\beta_{gal} = 2.33$ at $\alpha = 19^h$ to $\beta_{gal} = 2.53$ at $\alpha = 13^h$ for values of the temperature and the spectral index of the metagalactic component of the radio emission $T_{met} = 1800°K$ and $\beta_{met} = 2.75$ at the frequency 40 Mc. These variations of the spectral index are considerably larger than those reported earlier. To explain the observed galactic spectral index variations, a two-component model of the galactic radio-emission source distribution with different spectral indices of the components is considered. (auth)

22291 DISTANCES OF THE QUASI-STELLAR OBJECTS. Gunn, James E. (California Inst. of Tech., Pasadena). Astrophys. J.; 164: L113-18(15 Mar 1971).

It is shown that Ton 256 ($z = 0.131$) and PKS 2251 + 11($z = 0.323$) are associated with galaxies of essentially the same redshift, thus implying that these objects are at cosmological distances. The nature of Ton 256 is questionable, and it is argued that it represents a transition between Seyfert galaxies and QSOs. There is no doubt that PKS 2251 + 11 is a bona fide QSO; it is bright ($M_v = -24.7$), blue ($B - V = 0.20$, $U - B = -0.84$), has a starlike image under high resolution, and is a strong radio source. A peculiar emission structure near PKS 2251 + 11 is also discussed. (auth)

22292 RADIO EMISSION FROM QUASI-STELLAR OBJECTS. Wardle, J. F. C.; Miley, G. K. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 164: L119-22(15 Mar 1971).

Fifty-four "optical" QSOs were searched for radio emission at 2695 and 8085 MHz. Of three previously claimed detections, two are found to be almost certainly incorrect. No emission

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was detected from the remaining fifty-one objects at a level of about 0.01 f.u. (auth)

22293 DISCOVERY OF AN X-RAY SOURCE IN PERSEUS. Fritz, Gilbert; Davidsen, Arthur; Meekins, John F.; Friedman, H. (Naval Research Lab., Washington, D. C.). Astrophys. J.; 164: L81-5(15 Mar 1971).

A new x-ray source, Per XR-1, was observed. It may be associated with the Seyfert galaxy NGC 1275 (Per A, 3C 84). If the identification is correct, the x-ray power is 4×10^{45} ergs sec^{-1} (0.5 to 10 keV). (auth)

22294 X-RAY SPECTRUM OF SCORPIUS X-1 OBTAINED WITH A BRAGG CRYSTAL SPECTROMETER. Kestenbaum, H.; Angel, J. R. P.; Novick, R. (Columbia Univ., New York). Astrophys. J.; 164: L87-93(15 Mar 1971).

A measurement of the spectrum of Sco X-1 in the range 2.4 to 2.9 keV made with a high-resolution Bragg spectrometer shows no emission or absorption features. The Lα line of hydrogenic sulfur at 2.6 keV is found to have an equivalent width $\leq$2.2 eV, a factor 8 less than that predicted for an optically thin plasma at the observed temperature of 8×10^{7}°K. The result is explained by a high-density model for the source in which the line is weakened by electron scattering. (auth)

22295 DO PULSARS MAKE SUPERNOVAE? Ostriker, Jeremiah P. (California Inst. of Tech., Pasadena); Gunn, James E. Astrophys. J.; 164: L95-104(15 Mar 1971).

It is shown that both supernova remnants and visual supernovae require continuous energy input. The characteristics of pulsars, known to be associated with supernova remnants, make them ideal candidates for this energy source; in this picture both the expansion kinetic energy and the visual output are provided by the rotation of a neutron-star remnant. Comparisons with observations are made for the Crab Nebula, Vel X, Cas A, and η Car. (auth)

22296 MODEL OF PULSARS. Sturrock, P. A. (Stanford Univ., Calif.). Astrophys. J.; 164: 529-56(15 Mar 1971).

The model comprises a rotating neutron star ($R \sim 10^{6}$ cm) with a strong magnetic field ($B \sim 10^{12}$ gauss). Magnetic-field lines which reach the light cylinder are open field lines which connect to the surface of the star at the "polar caps." Each polar cap contains two zones, an electron polar zone (EPZ) and a proton polar zone (PPZ) from which electrons and protons, respectively, stream from the star. Acceleration of each stream is effected close to the surface of the star. Primary electrons in the EPZ follow magnetic-field lines; this acceleration leads to γ radiation. It is found that, if the period T is less than 1 sec, these γ rays annihilate to produce electron–positron pairs. Steady flow is then impossible, but flow comprising a sequence of charge sheets seems possible. These charge sheets produce radio emission. This may explain why most pulsars have periods shorter than 1 sec. If the sheets are thin, the spectrum varies as $\nu^{-\frac{1}{3}}$ and provides a good fit to the luminosity spectrum of CP 1919. If the sheet has a rectangular current distribution, the spectrum varies as $\nu^{-\frac{1}{2}}$ and provides a good fit to the radio luminosity spectrum of the Crab pulsar. In each EPZ of the Crab pulsar, γ-ray emission and pair creation combine in a cascade. The resulting flux of electrons and positrons from the star is of order 10^{41} sec^{-1}. The secondary electrons and positrons radiate by the synchrotron mechanism to yield a $\nu^{-\frac{1}{3}}$ spectrum, but the radiation is self-absorbed in the x-ray part of the spectrum and cannot explain the optical radiation from the Crab pulsar. The Crab pulsar spins rapidly enough for pair production to occur at the PPZs also, apparently out to several times R. In consequence, synchrotron radiation from the electron–positron flux is self-absorbed at much lower frequencies. It seems that the optical and x-ray radiation from the Crab pulsar can be understood quantitatively in this way. The optical, x-ray, and γ-ray flux expected from this model of the Crab pulsar can be reconciled with observation if the rotation axis, dipole axis, and line of sight are so related that radiation is received from both PPZs but no radiation from the EPZs. (auth)

22297 BRIGHTNESS DISTRIBUTION OF CORE-HALO RADIO SOURCES. Sramek, Richard Anthony. Pasadena, Calif.; California Inst. of Tech. (1970). 179p. University Microfilms Order No. 70-24,313.

Thesis.

The east–west visibility of 28 extragalactic radio sources with both large and very small components was obtained at 605 MHz using the radio interferometer at Owens Valley. A 2′ HPBW fan beam was synthesized from observations made at twelve spacings between 62 and 977 wavelengths. The availability of such low spatial frequencies permitted the calculation of the brightness distribution of components as large as 56′. Fourteen of the observed sources had a core–halo or asymmetric double structure and had their large components well resolved at the 977λ spacing. Assuming equipartition of magnetic and particle energies the total energies of the large halos are $\sim 10^{60}$ ergs. This is sufficient energy to maintain the current radio luminosities for $\sim 10^{10}$ years. Three of these fourteen sources have a core–halo structure and are associated with spiral galaxies; the remaining eleven are associated with elliptical galaxies. Two of the remaining sources are asymmetric doubles, and nine have a core–halo structure. Four of the core–halo sources have simple halos, two have double halos, and three have an undetermined halo structure. The ratio of observed double to simple halos can be explained by the projection of double halos randomly oriented in three dimensions provided the ratio of component separation to diameter, R, is less than two. Since doubles without a core have R between two and four, the mechanism of radio galaxy formation is likely to produce a core for low values of R. From the present investigation it is impossible to conclude whether there exists a class of core–halo radio galaxies with simple halos ($R \leq 1$) or whether the observed core–halo objects represent the low-R end of the ensemble of double radio sources. (TSS) (Diss. Abstr. Int., B)

22298 RADIO AND OPTICAL OBSERVATIONS OF THE SOURCE OZ-252. Andrew, Bryan H. (National Research Council, Ottawa); van den Bergh, Sidney; Conklin, Edward K.; Kraus, John D. Publ. Astron. Soc. Pac.; 83: 87-8(Feb 1971).

The source OZ-252 is associated with a quasi-stellar object that has a wide emission band at 5245 Å. (auth)

22299 PULSATING STARS. 2. A NATURE REPRINT. New York; Plenum Publishing Corporation (1969). 126p. $12.00.

This volume contains a selection of the articles that have appeared in the pages of Nature since autumn 1968. An introduction by T. Gold is included. (W.D.M.)

Solar Phenomena

Refer also to abstract 22391.

22300 (N–71-10291) PROBING THE SOLAR CORONA WITH SPACECRAFT RADIO SIGNALS. Wells, W.; Marquedant, R.; Hodara, H. (Tetra Tech, Inc., Pasadena, Calif.). Oct 1970. Contract NAS1-9167. 159p. (NASA-CR–1655; TC–163). NTIS.

A review of present knowledge of the corona shows that the region near the sun (a few solar radii) and the direction out of the ecliptic plane should be probed. Large-scale density and velocity structure should be studied and an attempt made to see whether the solar wind originates in small disturbances or large areas of the Sun's surface. Radio links were analyzed as were the connections between measurable radio parameters and their information content regarding the corona and its structures and parameters. The use of two microwave-carrier frequencies is recommended, probably S- and X-band, but no lower than S-band. An uplink propagation experiment (like the Stanford Pioneer 7) followed by data reduction on the spacecraft and downlink telemetry is preferable to insure reception with a strong signal-to-noise ratio. However, factors beyond the scope of this study could alter this conclusion in favor of a downlink, which greatly simplifies the craft and gives raw data at multiple ground stations. A passive-attitude control scheme for spin-stabilized spacecraft is recommended for this mission. The spin axis points stably toward the Sun, but lags slightly in following the Sun's apparent angular movement. Sun sensors can give instantaneous roll angle if this information is desired. The required torque derives from solar pressure acting on vanes that are fixed with respect to the craft. (auth) (STAR)

22301 (N–71-10430) LARGE-AMPLITUDE ALFVEN WAVES IN THE INTERPLANETARY MEDIUM. II. Belcher, John; Davis, Leverett Jr. (California Inst. of Tech., Pasadena. Dept. of Physics). Oct 1970. 81p. (NASA-CR–110999). NTIS.

An extensive study of the dynamic nonshock properties of the microscale fluctuations in the interplanetary medium was made using plasma and magnetic field data from Mariner 5. The observations show that (1) large-amplitude, nonsinusoidal Alfvén waves propagating outward from the Sun with a broad wavelength range from 1000 to 5,000,000 km dominate the microscale structure at least 50% of the time; (2) the purest examples of the outwardly propagating Alfvén waves occur in high-velocity solar-wind streams and on their trailing edges; (3) the largest-amplitude Alfvénic fluctuations are found in the compression regions at the leading edges of high-velocity streams where the velocity increases rapidly with time; (4) power spectra of the interplanetary

magnetic field in the frequency range from 1/(107 min) to 1/(25.2 sec) have frequency dependencies of f(−1.5) to f(−2.2); and (5) the microscale magnetic field fluctuations have an average power anisotropy of 5 : 4 : 1 in an orthogonal coordinate system. (auth) (STAR)

22302 (N-71-10913) DOSE-RESPONSE FUNCTIONS IN THE ATMOSPHERE DUE TO INCIDENT HIGH-ENERGY PROTONS WITH APPLICATION TO SOLAR PROTON EVENTS. Wilson, John W.; Lambiotte, Jules J. Jr.; Foelsche, Trutz; Filippas, Tassos A. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Nov 1970. 33p. (NASA-TN-D-6010; L-6947). NTIS.

The results of a recent high-energy nucleon transport calculation are presented as dose response functions at five altitudes in the atmosphere. The dose in extremities and the dose averaged over the body are directly calculated from these response functions by integration over the incident-energy spectra in the range 0.1 to 10 GeV. A dose–altitude profile is obtained by using all five sets of response functions. A geomagnetic cutoff model for normal magnetic field strengths is also presented. Doses for several solar events of solar cycle 19, including the high-energy event of February 12, 1956, are presented. The present results are compared with other calculations. (auth) (STAR)

22303 FINE-SCAN VELOCITY AND MAGNETIC-FIELD MEASUREMENTS IN SOLAR ACTIVE REGIONS. Bhatnagar, A. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 16: 40-50(Jan 1971).

Fine scan (5″ × 5″ aperture) simultaneous Doppler and magnetograms were obtained over solar active regions near the central meridian passage. Besides the mainly horizontal Evershed motion in sunspots, there appeared a conspicuous descending motion over all active regions. A comparison of Hα filtergrams with the fine scan magnetograms showed that dark filaments generally lie along the neutral longitudinal magnetic zone, while the Hα fibrils lie along the field lines, joining regions of opposite polarity. (auth)

22304 GEOMETRY OF THE CORONAL MAGNETIC FIELD. Altschuler, Martin D. (National Center for Atmospheric Research, Boulder, Colo.). Sky Telesc.; 41: 146-50(Mar 1971).

The method described for mapping the coronal magnetic field from photospheric data can trace the evolution of both the photospheric and coronal magnetic geometries. Despite limitations in data and time resolution, comparisons of the field maps with active solar features have been good so far. (W.D.M.)

22305 MODEL OF THE SOLAR PHOTOSPHERIC VELOCITY FIELD. Gonczi, G.; Roddier, F. (Faculte des Sciences, Nice). Astron. Astrophys; 11: 28-39(Mar 1971).

The velocity field in the solar photosphere is determined from an analysis of the geometrical properties (asymmetry and general shape) of the profiles of the Sr I 4607 line observed by Roddier (1965) with an atomic-beam spectrograph. Below an optical depth of 4×10^{-3} (at 5000 Å), the adopted model has two adjacent columns with different microturbulence which is anisotropic and increasing with depth. The column with the smallest microturbulence rises with a velocity of 0.7 km/sec and the other one descends with a velocity of 0.3 km/sec. This model gives profiles of Sr I 4607 from the center to the limb of the solar disk that are in good agreement with the experimental ones, and it is also in good agreement with some recent observations of the photospheric microstructures. (auth)

22306 SOLAR MAGNETIC FIELDS AND VELOCITIES. Giovanelli, R. G. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 1: 363-4(Sep 1970).

A comparison was made between solar magnetic-field regions, bright-line structures, and white-light faculae. It appears that only about half of the bright regions are associated with observed magnetic fields. Magnetic regions are identical with faculae to the limits of resolution (2 arc sec). Photospheric motions are thought to be reflected in the downward velocities of magnetic regions. The nature of the photosphere below the faculae, and the relation between the chromosphere and magnetic regions are still debatable. (Australia)

22307 SOME INVESTIGATIONS OF THE SOLAR CORONA: THE FIRST TWO YEARS OF OBSERVATION WITH THE CULGOORA RADIOHELIOGRAPH. Wild, J. P. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 1: 365-70(Sep 1970).

The first two years (1968–70) of systematic observations with the 80-MHz heliograph are described and discussed. Investigations relating to the quiet Sun, activity above sunspots, type-II, -III, -IV, -V, and U bursts and the flare continuum are described and illustrated. (48 references) (Australia)

22308 CONFIGURATION AND EVOLUTION OF SOLAR MAGNETIC FIELDS. Schatz, D. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 1: 371-2(Sep 1970).

Two hundred and sixty-two exposures were made over the period February 8, 1970—22 hr 59 min to February 9, 1970—07 hr 24 min on the Culgoora magnetograph. The solar fields appear as granular-shaped objects clumped together. Features of the configuration and evolution of the fields are depicted and discussed. (Australia)

22309 ON THE POLARIZATION AND RAPID FADE-OUT OF MOVING TYPE IV SOLAR BURSTS. Dulk, G. A. (CSIRO, Sydney. Univ. of Colorado, Boulder). Proc. Astron. Soc. Aust.; 1: 372-4(Sep 1970).

The polarization and intensity of synchrotron emission from mildly relativistic electrons are discussed. Strong circular polarization of the source region and rapid fade-out of moving type-IV sources are considered, due to dissipation of the magnetic field-structure within the moving source and betatron deceleration. An anisotropic pitch-angle distribution is produced with few electrons in circular orbits, resulting in an emission polar diagram with a peak that is not transverse to the magnetic field. Application is made to two type-IV sources. (Australia)

22310 ON THE INTERPRETATION OF WEAK SOURCES OF ENHANCED 80 MHz EMISSION IN THE SOLAR CORONA. Riddle, A. C. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 1: 375-6 (Sep 1970).

An interpretation of a solar radio enhancement of radius 0.95 $R_\odot$ and synodic period of 27.3 days is attempted in terms of the effects of refraction and opacity in model coronas. Two coronal models of streamer structure are considered. A thermal model with temperature enhancements within the streamer does not account for the observed apparent height of the source below the photosphere. However, this can be related to a nonthermal model in which the enhancements are attributed to emission from near the local plasma of nonthermal radiation. (Australia)

22311 80 MHz OBSERVATIONS OF THE MOVEMENT OF A TYPE IV SOURCE OUT TO 6 SOLAR RADII FROM THE CENTER OF THE SUN. Sheridan, K. V. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 1: 376-8(Sep 1970).

A moving type-IV radio source was observed on March 21, 1970, to move out to a distance of 6 solar radii. From a single source of complex shape, it developed strong circular polarization (>90% R.H.) and separated into components that retained the same polarization. Emission of synchrotron radiation may possibly come from a region, above a helmet structure, where the oppositely directed magnetic field lines relink across the neutral plane and the region moves outwards at the local Alfvén velocity. (Australia)

22312 PROBLEM OF SOLAR NEUTRINOS. Baglin, A. (Institute d'Astrophysique, Paris). J. Phys. (Paris), Colloq.; C3: 68-73(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

Recent measurements by Davis give an upper limit of the neutrino flux coming from the Sun. This upper limit is at least smaller than the predicted flux computed from solar models by a factor 2. A number of improvements in the computation of solar models have been made recently on the proton–proton cross section, chemical abundances in the Sun, $^3He-^3He$ reaction rate, and so on. Several physical processes involving mixing in the Sun, differential rotation, or diffusion have been tried to reach an agreement. No definite conclusion can be drawn at the moment. An improvement of the experiment that would lower the upper limit is badly needed to decide whether the physics used to treat the problem is wrong or not. (auth)

22313 LEPTON CONSERVATION AND NEUTRINO ASTRONOMY. Bouchiat, C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Phys. (Paris), Colloq.; C3: 74-77(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

Recent speculations of Gribov and Pontecorvo concerning an eventual violation of the conservation of leptonic and muonic numbers leading to $\nu_e \rightleftharpoons \nu_\mu$ oscillations similar to $K_0 \rightleftharpoons \overline{K}_0$ oscillations are discussed. After a short review of the experimental evidence for these conservation laws and a summary of the properties of the Dirac field with zero mass, a description of a model of violation proposed by Gribov and

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Pontecorvo is given. The implications of the model in neutrino-astronomy, particular attention being paid to the problem of solar neutrinos, are discussed. (auth)

22314 PRELIMINARY RESULTS OF THE RADIO-ASTRONOMICAL OBSERVATIONS DURING THE SOLAR ECLIPSE IN SEPTEMBER 22, 1968 AT THE WAVELENGTHS 0.8 AND 1.3 cm. Apushkinskii, G. P.; Enikeev, R. I.; Nagnibeda, V. G.; Tsyganov, A. N. Vestn. Leningrad. Univ., No. 13, Mat., Mekh., Astron.; No. 3, 127-32(Jul 1970). (In Russian).

The one-dimensional brightness distribution of the local sources over sunspot groups during the solar eclipse are given. Some preliminary results are discussed. (auth)

22315 HECTOMETRIC SOLAR NOISE STORMS: DETECTION OF CONTINUUM. Fainberg, Joseph; Stone, R. G. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 164: L123-5(15 Mar 1971).

The solar continuum has been detected at hectometric wavelengths during periods of solar storm activity. This suggests that during such periods a continuous stream of superthermal electrons is released into the interplanetary medium. (auth)

22316 GENERATION OF MAGNETIC FIELDS IN ASTROPHYSICAL BODIES. IV. THE SOLAR AND TERRESTRIAL DYNAMOS. Parker, E. N. (Univ. of Chicago). Astrophys. J.; 164: 491-509(15 Mar 1971).

The question of why the magnetic field of Earth is quasi-stationary in time while the field of the Sun is quasi-periodic is explored. Both fields are believed to be produced by a combination of nonuniform rotation and cyclonic turbulence, or Rossby waves. The calculations show that small dynamo numbers lead to stationary states, producing a dipole when the dynamo number is negative in the northern hemisphere, as in Earth. The dynamo number in the northern hemisphere of the Sun is positive, but fails to produce the stationary quadrupole field because of the high dissipation associated with the thinness of the convective region. The lowest mode available in the Sun is periodic in time, with the fields an odd function of latitude, as observed. The calculations show that a modest increase in the dynamo number in the Sun excites the quadrupole mode. In view of the observed north–south asymmetry of the solar magnetic fields, the periodic quadrupole mode may be excited much of the time. The important consequences of magnetic variation of the Sun for the space environment of Earth suggest that a more general theoretical exploration of the dynamo equations in spherical coordinates should be carried out. (auth)

22317 INFLUENCE OF HYPERFINE STRUCTURE ON SOLAR COBALT ABUNDANCE. Holweger, H.; Oertel, K. B. (Univ., Kiel). Astron. Astrophys.; 10: 434-6(Feb 1971).

Recent laboratory measurements of the hyperfine structure (hfs) were used to determine the effect of hfs on 25 Fraunhofer lines of Co I. Those lines having equivalent widths between 40 and 80 mÅ will simulate an average cobalt abundance ϵ_{Co} too high by about $\Delta \log \epsilon_{Co} = 0.25$ if hfs-broadening is neglected. (auth)

22318 CORONAL SCATTERING, ABSORPTION, AND REFRACTION OF SOLAR RADIO BURSTS. Steinberg, J. L.; Aubier-Giraud, M.; Leblanc, Y.; Boischot, A. (Observatoire, Meudon, France). Astron. Astrophys.; 10: 362-76(Feb 1971).

Using a statistical ray-tracing technique, the propagation of radio energy from a source radiating in a scattering, refracting, and absorbing spherical corona with isotropic irregularities of refractive index was studied. The treatment itself is described and its domain of validity discussed. It is shown that it can be used to study sources deep enough in the corona to model type III bursts. Reflected rays are taken into account. Computations are carried out for a point source at coronal levels where the index of refraction is 0.38 and 0.85 and for rms relative deviation in electron density $\epsilon = \text{rms}(\Delta N/N) = 1$ to 4%. The radius of correlation of the inhomogeneities is taken as $h = 5\ 10^{-5}\ \rho$ (ρ heliocentric distance in $R_\odot$, $h \cong 40$ km at $\rho = 1.1$). (W.D.M.)

22319 STATISTICALLY COMPARED STUDIES OF VELOCITY FIELDS IN A FACULAR REGION AND IN TWO QUIET REGIONS OF THE PHOTOSPHERE. Blondel, M. (Observatoire, Meudon, France). Astron. Astrophys.; 10: 342-53(Feb 1971). (In French).

The material is a time sequence of high-resolution spectra of the solar disk during 25 minutes. Spectra covered three regions of various structures: a quiet region used as a reference; a facular region contiguous to two spots; and a nonactive but excentered region for which the line of sight component of horizontal motions was not weak. A statistical study allowed a comparison of the velocity field, in the three regions, for 4 Fraunhofer lines of various strength and atmospheric levels by the corresponding Fourier power spectra. Important motions of low frequency are found in the excentered region in consequence of the supergranulation. Two narrow places of downward motion probably correspond with the boundaries of two "supergranules". In the facular region is observed a strengthening of the velocity field, for a part in low frequencies, but chiefly for waves apparently limited to periods less than 240 s. In the resonant range of 300 s, the lobe of the power spectra is enlarged and its power is reduced by 20% as compared to the quiet photosphere. A secondary oscillation appears with a period of about 700 s. The cross-correlation functions, between two lines, in quiet regions, confirms the quasi-stationary state of waves in the resonance peak region and their transition into traveling waves for periods less than 240 s. In the facular region, the curves of the phase lag deviate from the above law, with negative variations. This suggests the presence of evanescent waves with downward propagation. (auth)

22320 ACCELERATION OF RELATIVISTIC ELECTRONS IN SOLAR PROTON FLARES. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). Publ. Astron. Soc. Pac.; 83: 23-30(Feb 1971).

The acceleration mechanism of relativistic electrons in solar flares is considered by taking into account the physical condition of accelerating regions such as plasma density and magnetic field intensity. For the electrons of the kinetic energy range $\lesssim$10 MeV, it is shown that the Fermi acceleration is more effective than the betatron acceleration. The most plausible values of the plasma number density and the strength of sunspot magnetic fields in the accelerating regions are estimated to be $\lesssim 10^8$ to 10^{10} cm^{-3} and 10 to 10^2 gauss, respectively. This suggests that the accelerating regions are located somewhere above the Hα-flare regions. The accelerating regions may be identified with the triggering regions of solar flares where $8\pi P_{kin}/B^2 \ll 1$ (P_{kin}: kinetic plasma pressure; B: sunspot magnetic field intensity) and so they approximately satisfy the force-free condition as regards magnetic field configuration. The accelerated electrons and their relation to the emission of type-IV radio bursts are briefly discussed. (auth)

22321 COLOR INDEX OF THE SUN FROM THE Mg b TRIPLET. Fernie, J. D.; Hagen, J. Peter Jr.; Hagen, Gretchen L.; McClure, Lyn. (Univ. of Toronto). Publ. Astron. Soc. Pac.; 83: 79-80(Feb 1971).

The strength of the Mg b triplet was measured photoelectrically for 19 G and K dwarfs and for three of Jupiter's satellites. It was found that the Mg b index correlates well with (B – V) for these objects, and the solar value of the index was then used to derive a (B – V) value for the Sun. The result was $(B - V)_\odot = 0.628 \pm 0.011$. (auth)

22322 RESULT OF SPECIAL OBSERVATION FOR THE PROTON FLARE PROJECT 1969. 1. ON THE PFP OBSERVATION. Hakura, Yukio (Radio Research Lab., Tokyo). J. Radio Res. Lab., Tokyo; 17: 1-4(Jan 1970).

The present situation concerning the Proton Flare Project (PFP) is reviewed. Relativistic and subrelativistic protons from solar flares have been found. The dynamic spectral features of solar outbursts are considered as the most promising tool for clarifying the nature of proton flares. The first effort to monitor predicted terrestrial disturbances by international cooperation was made during the IGY and the IGC. Extensive studies resulted in the new techniques of proton flare forecasting. The monitoring of solar magnetic fields and the spectrum of centimeter radiowaves may predict solar flare in advance. This technique was adopted for world-wide study. On July 5, 1966, the first alert was issued successfully in advance, and observation brought ample information on the birth and growth of a solar active region, etc. Work by the Radio Research Laboratory in the project is summarized. The evidence of the major flare observed in the McMath plage region 10134 at 10 U.T. on June 5 is also summarized. (Japan)

Galaxies

22323 STABILITY OF A SELF-GRAVITATING PLASMA LAYER INCLUDING HALL EFFECT. Isaac, R. J.; Uberoi, C. (Indian Inst. of Science, Bangalore). Astron. Astrophys; 11: 107-10(Mar 1971).

The stability of a homogeneous, incompressible, infinitely conducting self-gravitating fluid layer in the presence of Hall effect is considered from the point of view of astrophysical interest. It is seen that the Hall effect removes the stability introduced by the

magnetic field. The nature of the instability bears a striking similarity to the case when finite resistivity is taken into account in the absence of Hall current. Some interesting features of the effect of Hall current and magnetic field on the maximum mode of instability are discussed. (auth)

22324 PHOTOMETRIC AND KINEMATIC STUDY OF SA 9. Jonas, D. (Observatoire, Marseille). Astron. Astrophys; 11: 123-33(Mar 1971). (In French).

A galactic area, SA 9, was studied in order to determine the galactic structure and rotation towards longitude $l^{II} = 139.3°$. Spectral types, distances, and radial velocities of stars between magnitudes 7.5 and 11.8 in a field of 16 square degrees are given. Plates used were taken at Observatoire de Haute Provence, with the two Fehrenbach's objective prism astrographs of 15 and 40 cm. Especial interest was taken in OBA stars, as these types are known to be good spiral arms tracers. A complete spectral classification of the field was made to recognize young stars among others. (W.D.M.)

22325 IS THE LOCAL GROUP A SINGLE STABLE CLUSTER? Van Den Bergh, Sidney (Univ. of Toronto). Astron. Astrophys; 11: 154(Mar 1971).

Available data on the space density of nearby bright spirals show that there is only a small (but perhaps not entirely negligible) probability that the Local Group of galaxies does not constitute a single dynamical unit. (auth)

22326 ONE POSSIBLE INTERPRETATION OF GALACTIC OH EMISSION. Delache, Philippe. (Faculte des Sciences, Nice). J. Phys. (Paris), Colloq.; C3: 21-2(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

It is shown that the transfer of the energy coming from an ionized hydrogen region (H II region) close to the anomalous OH emission center can take place through an unstable plasma wave, tuned at the frequency of one of the OH molecular transitions. (auth)

22327 N-BODY PROBLEM IN ASTRONOMY AND IN PHYSICS OF PLASMAS. Henon, Michel (Observatoire, Nice). J. Phys. (Paris), Colloq.; C3: 27-41(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

A formal similarity exists between a stellar system and a fully ionized plasma: in both cases, the force between the "particles" is proportional to $1/r^2$. A detailed relationship can be set up between the concepts, quantities, and equations used in both fields. This has led during recent years to a fruitful exchange of theoretical results and computational schemes. This last point is illustrated by some numerical experiments for "one-dimensional" systems (parallel planes or concentric spheres) and "two-dimensional" systems (parallel rods). (auth)

22328 CONTRIBUTION TO THE HELIUM CONTENT OF THE GALAXY FROM HOMOGENEOUS STARS. Ferrari, A.; Gallino, R.; Masani, A. (CNR, Turin. Univ., Turin. Osservatorio Astronomico di Brera, Milan). Astron. Astrophys.; 10: 481-5(Feb 1971).

Calculations on the contribution of the galactic He abundance from nonhomogeneously evolving stars give at present a value 2 to 3 times less than the observational value. An attempt is made to analyze the possible contribution from homogeneous evolving stars. With some plausible assumptions it is shown that this possibility exists. But, if a star evolves homogeneously through all thermonuclear phases, the ratio He/Z of the stellar matter diffused to interstellar medium would be of the order of unity. On the other hand, the mass loss from massive stars (eventually due to radial pulsation instability) is very large mainly during the H-burning phase (a 50 $M_\odot$ star ejects in space 41 $M_\odot$ in this phase; 24 $M_\odot$ of them represent the He contribution). So it is conceivable that this affects the mixing process and the homogeneous evolution is halted sometime during the H burning; the evolutive track of the star will correspondingly turn to the right of the HR diagram. Then the ratio He/Z could be very low. It is also shown that with some plausible assumptions the He contribution by homogeneous stars is much greater than that due to nonhomogeneously evolving stars during the first galactic phase ($t \lesssim 10^9$ y); at present the two contributions could be of the same order. It is considered that the ratio He/Z poses a difficult problem for the nonhomogeneous evolution also, in particular after recent results which seem to exclude that massive stars leave remnants at the end of their evolution. (auth)

22329 OBSERVATIONAL APPROACH TO THE PROBLEM OF SPIRAL STRUCTURE. Dixon, M. E. (Australian National Univ., Canberra). Astrophys. J.; 164: 411-23(15 Mar 1971).

A method is described by which the mechanism that produces spiral structure may be investigated. The method is based on (B, V) photometry of individual stars and is illustrated by reference to stars in the outer (R > 3 kpc) parts of the southern spiral arm of M33. Present results indicate that outside R = 3 kpc there is an age progression across the southern spiral arm and that the older stars are at the inner edge of the arm. The results are interpreted in terms of the spiral-wave picture of spiral structure. An alternative interpretation, involving a spatial separation of recently formed stars and the gases in which they were born, does not fit the observations. Present observational data permit a rough estimate of pattern speeds. They indicate that, at R = 3.4 kpc, $(V_p - V_g) \approx +12$ km sec^{-1}, where V is the tangential component of velocity, the subscript p refers to the pattern, and the subscript g refers to the gas. If this result is correct, if the pattern rotates "rigidly," and if Brandt's rotation curve for the interstellar gas is correct, then $V_p = V_g$ at R = 2.8 kpc and $V_p < V_g$ at R < 2.8 kpc. (auth)

22330 NEW CLOUD OF HYDROGEN EMISSION IN A BRIGHT GALACTIC NUCLEUS. Khachikyan, Edward E. (Byurakan Astrophysical Observatory, Erevan); Weedman, Daniel W. Astrophys. J.; 164: L109-11(15 Mar 1971).

Observations are discussed which show that new Balmer emission lines, blueshifted by 3000 km sec^{-1} from the original lines, appeared in the nucleus of the galaxy Markarian 6 (IC 450) during a period of less than one year. The new emission-line components are not seen in the forbidden lines and are attributed to a high-density cloud of ionized gas which has developed in the nucleus. (auth)

22331 AIRBORNE INFRARED ASTRONOMY. Aumann, Hartmut Hans-Georg. Houston, Tex.; Rice Univ. (1970). 120p. University Microfilms Order No. 70-23,476.

Thesis.

An airborne infrared telescope was developed that allows observations of astronomical objects beyond 25 microns, a region of the spectrum where the Earth's atmosphere is opaque. Flux measurements of the infrared nebula in Orion, the galactic center, and NGC 1068 are reported and analyzed. (TSS) (Diss. Abstr. Int., B)

22332 LARGE-SCALE SPATIAL DISTRIBUTION OF NEUTRAL HYDROGEN IN GALAXIES. Bottinelli, L. (Observatoire, Meudon, France). Astron. Astrophys.; 10: 437-49(Feb 1971).

The 21-cm line profile of neutral atomic hydrogen was measured with the Nançay radio telescope, at several points, in 36 relatively distant (up to 15 Mpc) galaxies from lenticular to irregular types. The neutral hydrogen was found displaced by a significant fraction ($\approx 1/3$) of a beamwidth with respect to the optical center, in about 40% of the galaxies. These asymmetrical distributions do not seem always correlated with the presence of neighboring galaxies. The large-scale H I distributions were characterized by H I diameters. The ratio of this H I diameter to the optical one was found correlated with the type: it increased by about a factor of 2 when going from types Sb to irregular. The large-scale distribution of the H I projected density was studied for 33 galaxies. Its consistency with a ring-like model was investigated: in 1/3 of the cases it appears suitable. The variation of the H I to optical diameters ratio with the type allowed the determination of an intrinsic mean H I projected density which was found to be rather independent of the type. It is shown that the variation with the type of the usually adopted mean H I projected density reflects, in fact, the correlation existing between the H I to optical diameters ratio and the type. The neutral hydrogen seems to be more strongly concentrated towards the central regions in the Sb galaxies than in the Sm and Irr ones. A gaussian distribution of the H I volumic distribution density being assumed, the optical limit of a galaxy seems to be characterized by the same range of H I volumic density values, for all morphological types, which corresponds possibly to about a same low rate of star formation. (auth)

22333 INTERFEROMETRIC STUDY OF IONIZED HYDROGEN IN THE SMALL AND IN THE LARGE MAGELLANIC CLOUDS. Carranza, G.; Monnet, G.; Cheriguene, M. F. (Observatoire, Cordoba, Argentina. Observatoire, Marseille. Observatoire, Haute Provence, France). Astron. Astrophys.; 10: 467-8(Feb 1971). (In French).

Some results obtained by H_α Perot–Fabry interferometry on H II regions in the Small and Large Magellanic Clouds are presented. Plates taken at the 60-inch refractor of Cordoba Observatory cover circular fields of diameter 20 arc min and permit a very detailed study of complex H II regions. (auth)

22334 DETERMINATION OF THE DIFFERENT COMPONENTS IN THE CONTINUUM FROM THE NUCLEI OF GALAXIES.

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Alloin, Danielle (Institut d'Astrophysique, Paris); Andrillat Yvette; Souffrin, Suzy. Astron. Astrophys.; 10: 401-13(Feb 1971).

A method is described for determining the stellar population and any reddening or excess of radiation in the nuclei of galaxies. (W.D.M.)

22335 COSMOLOGICAL REDDENING OF FIELD GALAXIES. Noonan, Thomas W. (Brockport State Coll., N. Y.). Publ. Astron. Soc. Pac.; 83: 40-2(Feb 1971).

The reddening of field galaxies is equal to kz, where k is the linear coefficient in the K correction $K_{B-R}(z) = kz$, and z is the solution to the redshift–magnitude relation $\log z = 0.2m - 4.630$, where m is the apparent magnitude as seen outside the Galaxy, K-corrected for the redshift z. This result holds out to un-K-corrected magnitude 18.7m (pg). (auth)

Cosmology

22336 GRAVITATIONAL ENERGY YIELDS. Bondi, Hermann. J. Phys. (Paris), Colloq.; C3: 24-6(Nov-Dec 1969).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

The phase of slow gravitational contraction of a spherical body, with its control by radiation from the body, is contrasted with the dynamical collapse that occurs when gravitation is not balanced by pressure forces. It is shown that, in general relativity, contraction inevitably changes to collapse when the gravitational potential energy becomes a significant fraction of rest mass. Therefore, gravitation can only convert at most about 1% of rest mass into radiation. (auth)

22337 QUANTUM MECHANICS OF GRAVITATIONAL FORCES AND STABILITY OF MATTER. Levy-Leblond, Jean-Marc. (Physique Theorique, Nice). J. Phys. (Paris), Colloq.; C3: 43-55 (Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.2.

Starting directly from the fundamental principles of physics, the cohesion and stability of matter under the action of gravitational forces is investigated. Given a system of N particles mutually interacting via gravitational forces, one studies the existence and variation with N of the ground-state energy. Quantum effects, and particularly the statistics (Bose or Fermi) obeyed by the particles, play a crucial role. Very simple heuristic arguments, backed up by a rigorous analysis, explain: (a) how and when gravitational forces take over Coulomb forces for large enough systems of "ordinary matter" (planets); (b) why, because of relativistic effects, there is no stable system with mass higher than a certain critical mass, which is evaluated (Chandrasekhar limit: white dwarf stars); and (c) why at still higher densities (neutron stars) general-relativistic effects worsen the situation and gravitational collapse cannot be avoided. (auth)

22338 THERMODYNAMICS OF STRONG INTERACTIONS AT HIGH ENERGIES AND ITS CONSEQUENCES FOR ASTROPHYSICS. Hagedorn, R. (CERN, Geneva). J. Phys. (Paris), Colloq.; C3: 79-88(Nov-Dec 1969).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

Statistical thermodynamics in a particular form derived from high-energy physics is used to describe the thermodynamical properties of what might have been the universe before its energy density became much lower than nuclear density. The main features are: (a) even if it started with infinite energy density, it never had a temperature greater than $T_0 = 160$ MeV (1.86×10^{12}°K), which is the universal highest temperature in this theory; (b) for very large energy density the pressure is not, as in usual theories, proportional to the energy density but only to its logarithm; and (c) inside each elementary volume V_0 (≈nucleon volume) the energy fluctuates by amounts of the order of the total energy contained in V_0. For infinite energy density this fluctuation does not vanish as in ordinary theories, but tends to $\Delta E/E \approx 0.4$. The conjecture is proposed that smaller, but still substantial, fluctuations of the baryonic quantum number may go along with the energy fluctuations. (auth)

22339 SEPARATION OF MATTER AND ANTIMATTER AT VERY HIGH TEMPERATURE. Omnes, R. (Physique Theorique et Hautes Energies, Orsay, France). J. Phys. (Paris), Colloq.; C3: 89-93(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

The initial state of the Lemaitre–Gamow cosmological model is considered, and the stability of the blackbody radiation is discussed relative to the separation of matter and antimatter suggested by Harrison. A mechanism, based on the properties of the nucleon–antinucleon interaction at intermediate energies, is studied in detail. A direct comparison is also made between observations and consequences of the existence of antimatter at the end of the hadronic era. Satisfying results are obtained for the density of matter in the Universe and for a model of quasar. (auth)

22340 POST-NEWTONIAN EQUATIONS OF HYDRODYNAMICS FOR A THERMALLY CONDUCTING, VISCOUS, COMPRESSIBLE FLUID IN GENERAL RELATIVITY. Greenberg, Philip J. (Univ. of Chicago). Astrophys. J.; 164: 569-87(15 Mar 1971).

The equations of hydrodynamics governing the behavior of a thermally conducting, viscous, compressible fluid in the first post-Newtonian approximation to general relativity are derived. In addition, conservation laws for the mass, the linear momentum, the angular momentum, and the energy of the entire system are obtained. The expressions (expansion, rotation, and shear) are also tabulated which describe the deformations of the fluid as seen by an observer comoving with an element of the fluid and employing three Fermi-transported, local, Cartesian axes. It is observed that use of geometrical invariants is convenient for the physical interpretation of these expressions in the post-Newtonian approximation. (auth)

22341 POST-NEWTONIAN EQUATIONS OF MAGNETOHYDRODYNAMICS IN GENERAL RELATIVITY. Greenberg, Philip J. (Univ. of Chicago). Astrophys. J.; 164: 589-601 (15 Mar 1971).

The equations of magnetohydrodynamics governing the behavior of a charged, conducting fluid in the first post-Newtonian approximation to general relativity are derived. In addition, conservation laws for the mass, the linear momentum, the angular momentum, and the energy of the entire system are obtained. (auth)

22342 QUALITATIVE COSMOLOGY. DIAGRAMMATIC SOLUTIONS FOR BIANCHI TYPE IX UNIVERSES WITH EXPANSION, ROTATION, AND SHEAR. Ryan, Michael Patrick Jr. College Park, Md.; Univ. of Maryland (1970). 141p. University Microfilms Order No. 71-4093.

Thesis.

The history of cosmology as an intellectual discipline is discussed, with attention on the unsolved problem of universes that exhibit rotation as well as expansion and shear (solutions with both expansion and shear are well known). A solution of the Einstein equations was obtained for a universe whose three-space sections are spaces of Bianchi type IX in the sense of a pictorial or diagrammatic solution. While it has been known for some time that such universes have a singularity at some point in their evolution, there has been speculation on the nature of this singularity. It is shown by means of a diagrammatic solution that the singularity in this case is very close in character to that of universes that have only expansion and shear. Rotation changes the singularity very little. While a brief discussion of the possibility of obtaining exact numerical solutions for Bianchi type-IX universes is given, the major portion of the thesis is devoted to a discussion of the application of the techniques of Arnowitt, Deser, and Misner to obtain a diagrammatic solution. Two types of rotating Bianchi type-IX universes with decreasing degrees of symmetry are considered, the symmetric universe of Gödel and the most general possible universe of this type. With these diagrammatic solutions at hand the singularity of the symmetric case was examined and the results mentioned above were obtained. A brief discussion of Wheeler's concept of superspace as applied to Bianchi type-IX cosmologies is given. Two types of observations in these universes were considered, the isotropy of the 3°K black-body radiation and the present ratio of hydrogen to helium in the Universe, due in part to the production of helium at high temperatures in the early Universe. The low limit on the amount of rotation possible in these universes because of the isotropy of the blackbody radiation is shown to make the effect of this rotation on the production of helium undetectable by any means known today. (Diss. Abstr. Int., B)

22343 MEAN COSMIC DENSITY BASED ON MASSES OF CLUSTERS OF GALAXIES. Noonan, Thomas W. (Brockport State Coll., N. Y.). Publ. Astron. Soc. Pac.; 83: 37-9(Feb 1971).

The mean ratio R of mass to total $10^{-0.06M}$, where M is absolute magnitude, for clusters of galaxies (particularly the Coma cluster) was derived and used to obtain the mean cosmic density based on the assumption that field galaxies have the same mean R as cluster

galaxies (including the "unseen" mass). The result was $\rho = (5 \pm 2) \times 10^{-30}$ g cm^{-3} for H = 100 km sec^{-1} Mpc^{-1}. (auth)

22344 LOCAL MEAN COSMIC DENSITY FROM DOUBLE-GALAXY DATA. Noonan, Thomas W. (Brockport State Coll., N. Y.). Publ. Astron. Soc. Pac.; 83: 35-6(Feb 1971).

Page's work on double galaxies was extended to the ratio of mass to $10^{-0.6M}$, where M is the absolute magnitude. The resulting mean cosmic density to a distance of order 10^2 Mpc is $(1.6 \pm 1.6) \times 10^{-30}$ g cm^{-3} for H = 100 km sec^{-1} Mpc^{-1}. (auth)

22345 MEAN COSMIC DENSITY FROM GALAXY COUNTS AND MASS DATA. Noonan, Thomas W. (Brockport State Coll., N. Y.). Publ. Astron. Soc. Pac.; 83: 31-4(Feb 1971).

Use of the mean ratio of mass to $10^{-0.6M}$, where M is the absolute magnitude, instead of the ratio of mass to $10^{-0.4M}$ (luminosity) allows determination of the mean cosmic density from galaxy counts and galaxy masses alone, without the need for luminosity functions. Available data indicate a mean density of 2 to 5×10^{-31} g cm^{-3} for a Hubble constant of 100 km sec^{-1} Mpc^{-1} to a distance of order 10^2 Mpc. The greatest uncertainty comes from galaxy masses and galaxy counts, rather than galactic absorption or abundances of galaxy types. (auth)

Planetary Phenomena

22346 (N-71-10051) PARTICLES AND FIELDS NEAR JUPITER. Warwick, James N. (Jet Propulsion Lab., Pasadena, Calif.). Oct 1970. Contract NAS7-100. 126p. (NASA-CR-1685). NTIS.

Data on particles and fields near Jupiter based on interpretations of Earth-based observations of radio emissions in the higher-frequency ranges are summarized, and elementary physical principles and probable uncertainties in the results are discussed. Jupiter's magnetic field appears to be dipolar, with a moment of value 4.2×10^{30} c.g.s., directed at 7.7° to the rotation axis. There is evidence for a small quadrupole moment, about 0.06 R_J in units of the dipole moment. Typical energies for the relativistic electron fluxes are estimated to be 10 MeV and represent a range of about 3 to 30 MeV. Lower-energy electrons are much more difficult to estimate, and proton fluxes are virtually unknown on the basis of available data. However, sensitive upper limits to the thermal plasma density in the magnetosphere were established empirically. (auth) (STAR)

22347 SUPERCONDUCTIVITY OF JUPITER. Pincus, P. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), Colloq.; C3: 19-20(Nov-Dec 1969).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

It has been suggested by Ashcroft that, if solid hydrogen has a metallic phase (under a pressure >1 megabar), such a phase could be a superconductor with very high critical temperature. Orders of magnitude for its superconductive properties (T_c, H_c, k, etc ...) are considered in relation with the physical conditions in the planet Jupiter. The possibility that supercurrents create Jupiter's magnetic field is discussed. (auth)

22348 CHEMICAL ALTERATIONS RESULTING FROM PROTON IRRADIATION OF THE LUNAR SURFACE. Zeller, E. J.; Dreschoff, G.; Kevan, L. Mod. Geol.; 1: 141-8(1970).

Substantial chemical alteration of the lunar surface may be expected as a result of proton flux incident upon it. Water and hydroxyl ions are produced when silicates are irradiated with protons, and hydrocarbons may be formed if carbon-rich materials are present on the Moon's surface. Sputtering by solar-wind protons can remove the reaction products at the surface, but those formed deeper by solar-flare and cosmic protons can be retained. Chemical reduction can occur along the proton track by formation of trapped electrons and other reducing species: protons can also act as reducing agents at the end of their tracks by forming either hydrogen atoms or hydride ions. Breakage of chemical bonds and lattice disorder resulting from proton irradiation can cause energy storage in solid materials. These radiation damage effects with observed chemical alterations suggest the chemical reactivity of lunar surface material will be considerably greater than that of terrestrial rocks. (Geophys. Abstr.)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 22587, 22603, 22617, and 22619.

22349 ENERGY SPECTRA OF INELASTICALLY SCATTERED AND AUGER ELECTRONS FROM SINGLE CRYSTALS. Shul'man, A. R.; Korablev, V. V.; Morozov, Yu. A. (Leningrad Polytechnical Inst.). Sov. Phys.-Solid State (Engl. Transl.); 12: 1487-8(Dec 1970).

Translated from Fiz. Tverd. Tela; 12: 1866-8(Jun 1970).

An apparatus for single and double differentiation of secondary-current retardation curves is described. The derivative of the electron energy spectrum of Si single crystals shows several Auger peaks; $M_{II} - L_{II} = 91$ eV, in good agreement with x-ray absorption. The electron energy-loss spectra of Mo single crystals were also studied by differentiation; energy losses of 11 and 23 eV were found. (D.L.C.)

22350 CROSS SECTIONS OF ATOMS FOR ELASTIC AND INELASTIC SCATTERING OF ELECTRONS. Lenz, Friedrich (Univ., Tuebingen, Ger.). Ber. Bunsenges. Phys. Chem.; 74: 1187-90(Nov 1970)

The differential and integral cross sections for the elastic and inelastic scattering of electrons by atoms are discussed. The differential scattering cross section describes the angular distribution of the scattered electrons while the integral cross section is a measure of the fraction of the incoming electron current that is scattered. The dependence of the cross sections on scattering angle, electron energy, and atomic number of the scatterer is explained. The role of the scattering cross sections in the theory of electron microscopic scattering absorption contrast and phase contrast is discussed. An expression for the cross section describing the probability for a displacement of an atom from its equilibrium position by momentum transfer is derived. (auth)

22351 EQUILIBRIUM CHARGE DISTRIBUTION IN A BEAM OF FAST HEAVY IONS. Nikolaev, V. S.; Dmitriev, I. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1383-5(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1773-6(Aug 1970).

Experimental data on the average charge $\bar{I}$ and d, the width of the equilibrium charge distribution in beams of fast ions with atomic number $Z \gtrsim 5$, after passage through solids, are discussed; semiempirical equations that give $\bar{I}$ to be ~3 to 5% and d to 20 to 30%, unique for $Z \geq 20$, are derived. The equations correspond to the generalized Bohr criterion for loss and retention of electrons in fast ions when the statistical model is used. The effect of shell structure on the values of $\bar{I}$ and d for large Z is discussed. (auth)

22352 METHOD FOR OBTAINING SLOW-ELECTRON BEAMS. Balaev, N. F.; Kuz'min, R. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1187-9(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1537-9(Jul 1970).

A method is presented for obtaining intense beams of electrons with energies from a few electron volts down to thermal energies. Compensating the electron space charge by positive ions formed by surface ionization allows the electrons to travel a long distance from the emitter. Slow electron beams with currents from 0.2 to 20 A are obtained. The conditions affecting the electron energy are investigated experimentally. (auth)

22353 NEW APPROACH TO MEASURE ION REFLECTION AND SECONDARY ION EMISSION DURING ION BOMBARDMENT OF ATOMICALLY CLEAN AND SMOOTH MONOCRYSTALLINE METAL SURFACES. Suurmeijer, E. P. Th. M.; Boers, A. L.; Begemann, S. H. A. (Univ. of Groningen, Netherlands). Surface Sci.; 20: 424-8(Apr 1970).

Experiments are underway for studying ion reflection and secondary ion emission from monocrystalline metal targets during bombardment by 0.5- to 10-keV noble gas ions. To avoid the disadvantages of conventional cleaning methods, the target will be formed by periodic epitaxial deposition on the substrate by evaporation. The time between successive evaporation runs will be used to measure ion reflection and secondary emission. In order to minimize contamination, low pressures ($<10^{-10}$ torr) and small primary-ion current densities ($\leq 10^{-8}$ A/cm^2) will be used. The experimental setup is described. (D.L.C.)

Atomic and Molecular Properties

Refer also to abstracts 22506 and 22879.

22354 (UUIP-690) TABLE OF PERTURBATION COEFFICIENTS FOR A FREE HYPERFINE INTERACTION IN A PARALLEL EXTERNAL MAGNETIC FIELD. Falk, F.; Linnfors, A.; Orre, B.; Thun, J. E. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1970. 21p. Dep. NTIS (U. S. Sales Only).

Integral attenuation coefficients of angular correlations per-

turbed by a free hyperfine interaction and a parallel external magnetic field were calculated. Nuclear spins I from 1 to $^5/_2$ and atomic spins J less than $^5/_2$ are considered. The internal interaction is assumed to be of magnetic origin. (auth) (Sweden)

22355 PHOTOELECTRIC YIELD. Kusnezov, N. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 190-2(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

In some experiments it is of interest to be able to estimate the photon-produced emission current at higher energy, and for this purpose calculations were performed. The calculated curves include contributions due to the photoelectric, Compton, and Auger effects. A method for estimating the fluorescent contribution is proposed and the results of calculations are presented. (auth)

22356 CORRELATED AND HARTREE–FOCK WAVE FUNCTIONS FOR THE 1s2s ^{3}S STATE OF HELIUM. Carlton, Terry S. (Oberlin Coll., Ohio). J. Chem. Phys.; 54: 2618-20(15 Mar 1971).

Energies are calculated variationally using an antisymmetrized orbital product times the correlation function $g = [1 + \lambda r_{12} + \mu(r_2 - r_1)^2]^m$ for m = $^1/_2$ or 1. Energy errors are 0.00013 a.u. when m = $^1/_2$ and 0.00030 a.u. when m = 1. Values of λ and μ are considerably smaller than in the case of the ground state. The Hartree–Fock energy is found to be −2.17425 a.u. Various expectation values are reported for all wave functions. (auth)

22357 VARIATIONAL WAVE FUNCTIONS AND ENERGIES FOR L = 2 AND L = 3 STATES OF TWO-ELECTRON ATOMS. Brown, Robert T. (EG and G, Inc., Las Vegas, Nev.); Cortez, Jose-Luis M. J. Chem. Phys.; 54: 2657-9(15 Mar 1971).

Variational wave functions and energies have been obtained for the n^1D, n^3D, n^1F, and n^3F (through n = 8) levels of the helium isoelectronic sequence through Z = 16. The trial functions are configuration-interaction expansions in members of a denumerably complete basis set (Sturmian functions), with 39 terms used for the D states and 18 terms used for the F states. Differences between calculated and observed D state energies of He and Li^+ range from 0.000001 to 0.00005 a.u. (auth)

22358 CUBIC AND QUARTIC FORCE CONSTANTS FOR H_2^+. Bishop, David M. (Univ. of Ottawa). J. Chem. Phys.; 54: 2761-2(15 Mar 1971).

Previous calculations (J. Chem. Phys., 53: 1541 (1970)) of harmonic force constants for the ground state of H_2^+ are extended to cover the cubic and quartic force constants. Parameters, energy, and energy derivatives for the ground state of H_2^+ for the internuclear equilibrium separation are presented. These values are used to define a simpler, though less precise, energy function than that previously used, and results of calculations using this function are tabulated. (A.G.W.)

22359 EXPERIMENTAL STUDY OF THE DECAY OF THE He^- ION. Simpson, F. R.; Browning, R.; Gilbody, H. B. (Queen's Univ., Belfast). J. Phys., B (London); 4: 106-10(Jan 1971).

The decay in flight of He^- ions was studied under field-free conditions. Measurements with He^- beams of energies between 2 and 30 keV in flight tubes from 0.1 to 1.7 m long established the existence of two components with greatly different lifetimes present in approximately equal proportions in the beam. The lifetime of the long-lived component appears to be comparable with that predicted theoretically for the $^4P_{^1/_2}$ state, whereas the second component, which dominates the observed decay, has a lifetime of 9^{+3}_{-2} μsec. (auth) (UK)

22360 BINDING ENERGY OF HELIUM ATOM BY FADDEEV FORMALISM. Banerji, G.; Banerjee, S. N.; Sil, N. C. (Indian Association for the Civilization of Science, Calcutta). J. Phys., B (London); 4: L5-6(Jan 1971).

The energy for the three-particle ground state of the (e^-, He^+) system, namely that of the helium atom was calculated using Faddeev theory and following the method of Ball et al (1968). Retaining only 1s and 2s terms in the Sturmian set expansion for the two-body collision amplitude, the result is found to be in good agreement with experimental measurement. (auth) (UK)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 23086.

Collision Phenomena

Refer also to abstract 22581.

22361 (N–70-42220) EXCITATION OF N_2 AND N_2^+ SYSTEMS BY ELECTRONS. II. EXCITATION CROSS SECTIONS AND N_2 1PG LOW-PRESSURE AFTERGLOW. Shemansky, D. E.; Broadfoot, A. L. (Pittsburgh Univ., Pa. Space Research Coordination Center). 25 Sep 1970. 87p. (NASA-CR–114190; SRCC–140). NTIS.

Quantitative optical measurements of the N_2 first and second positive and N_2^+ Meinel systems excited by electrons allowed measurement of transition probabilities, excitation cross sections, and afterglow effects. The excitation cross sections were determined relative to that of the N_2^+ (0,0) first negative band. The estimated total peak electron cross section of the $B^3\Pi_g$ state is 1.2×10^{-16} cm^2, about a factor of 2 larger than other recently published estimates. The total peak cross section of the $C^3\Pi_u$ state is estimated to be 3.8×10^{-17} cm^2. (auth) (STAR)

22362 (N–70-42257) DIFFERENTIAL SCATTERING WITH CHARGE TRANSFER TO THE 2s STATE OF HYDROGEN FROM H^+–He AND H^+–Ar COLLISIONS. Crandall, David H. (Nebraska Univ., Lincoln. Dept. of Physics). Aug 1970. 186p. (NASA-CR–114270). NTIS.

Thesis.

For collisions of protons with helium and argon target gases, the differential cross sections for total scattering, the probabilities of charge transfer forming a hydrogen atom, and the probabilities of charge transfer forming a hydrogen atom in the 2s state were measured. The measurements were differential in the angle to which the incident particle was scattered and were made for the range of incident proton energies between 3 and 20 keV. Scattering angles between 1 and 7° were used. (auth) (STAR)

22363 MOMENTUM TRANSFER CROSS SECTION FOR ELECTRONS IN HELIUM DERIVED FROM DRIFT VELOCITIES AT 77°K. Crompton, R. W.; Elford, M. T.; Robertson, A. G. (Australian National Univ., Canberra). Aust. J. Phys.; 23: 667-81(1970).

Drift velocities of electrons in helium at 76.8°K were measured for $8 \times 10^{-20} < E/N < 2 \times 10^{-17}$ V cm^2. From these data, and the earlier measurements of Crompton, Elford, and Jory made at 293°K, the energy-dependent momentum-transfer cross section was determined for electrons with energies between 0.008 and 6 eV. The present cross section agrees with that of Crompton, Elford, and Jory to within 1%. The extension of the energy range to 8 MeV permits a direct determination of the scattering length, for which a value of 1.19 a_0 is obtained. (auth)

22364 CROSS SECTIONS FOR ROTATIONAL EXCITATION OF H_2 AND D_2 BY LOW ENERGY ELECTRONS. Gibson, D. K. (Australian National Univ., Canberra). Aust. J. Phys.; 23: 683-96(1970).

The J = 1 → 3 rotational cross section for H_2 was derived from an analysis of electron transport coefficients. A new technique is described for calculating the energy distribution functions taking into account superelastic collisions, since these must be included for an analysis of low-energy transport data in D_2. Unique rotational cross sections cannot be obtained for this gas from the experimental data available, but two sets of cross sections have been derived, which are compatible with the existing data and are also in accord with recent theoretical calculations. Evidence is also presented to show that there is probably a small difference between the momentum-transfer cross sections in H_2 and D_2. (auth)

22365 OPACITY ANALYSIS OF INELASTIC MOLECULAR COLLISIONS. VI. THE SUDDEN APPROXIMATION FOR ROTATIONAL EXCITATION. Levine, R. D. (Hebrew Univ., Jerusalem). J. Chem. Phys.; 54: 997-1004(1 Feb 1971).

The limited coupling domain (where only first-order-allowed transitions are important) for rotational excitation is considered using the quantum mechanical sudden approximation. The derivation of the approximation is discussed using a variational procedure, and a simplified form valid for large angular momentum is introduced. A further simplification is achieved using the limited coupling form of the S matrix, which interpolates between the weak coupling (distorted-wave) limit and the dominant coupling regime. Explicit results are obtained for differential and total cross sections of specified first-order-allowed rotational transitions of diatomic molecules. The inelastic cross sections are expressed in terms of a coupling parameter and a common cross section, and the angular distribution, evaluated using a semiclassical summation, is peaked at a forward angle θ_0, with $E\theta_0$ increasing with increasing collision energy. (auth)

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22366. ANALYTICAL DISTORTED-WAVE BORN SERIES FOR VIBRATIONAL INELASTIC SCATTERING. Roberts, R. E. (Indiana Univ., Bloomington). J. Chem. Phys.; 54: 1224-5 (1 Feb 1971).

The distorted-wave Born series, as developed by Thiele and Weare, is used to determine a simple second-order correction for the Jackson–Mott theory of vibrational inelastic scattering. The higher-order expression for the transition probability suggests an improved method for carrying out the usual first-order perturbation treatment, which gives good agreement with exact results. (auth)

22367 ELECTRON LOSS BY C^- AND O^- IONS IN GASEOUS TARGETS. Matic, M.; Cobic, B. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). J. Phys., B (London); 4: 111-15 (Jan 1971).

Cross sections of one-, two-, and three-electron loss processes for C^- and O^- on Ne, Ar, Kr, Xe, and N_2 were measured over an energy range of 5 to 30 keV, using a beam technique. One-electron-loss cross sections $\sigma_{\bar{1}0}$ varied in the range of 10^{-16} to 10^{-15} cm^2, while two-electron-loss cross sections $\sigma_{\bar{1}1}$ were found to be an order of magnitude lower than $\sigma_{\bar{1}0}$, in the present energy range. Three-electron-loss cross sections $\sigma_{\bar{1}2}$ increased sharply with the incident ion energy and their values ranged from 10^{-20} to 10^{-17} cm^2. The dependence of the measured cross sections on gas-target mass number, incident ion characteristics, and energy is discussed. (auth) (UK)

22368 EXCITATION OF THE CO FOURTH POSITIVE BAND SYSTEM BY ELECTRON IMPACT ON CARBON MONOXIDE AND CARBON DIOXIDE. Mumma, M. J.; Stone, E. J.; Zipf, E. C. (Univ. of Pittsburgh). J. Chem. Phys.; 54: 2627-34(15 Mar 1971).

Absolute excitation cross sections were measured for five vibrational bands of the CO ($A\ ^1\Pi - X\ ^1\Sigma^+$) fourth positive band system. The bands were produced by electron impact on CO and CO_2, and the cross sections were measured from threshold to 350 eV. Relative intensity measurements on 28 bands were used to determine the dependence of R_e on the r centroid, which is $R_e = 1.9\ (1.0 - 0.6\bar{r}_{v'v''})$. Absolute transition probabilities were computed using this functional form for R_e and normalizing the total transition probability of the $v' = 2$ level to published experimental results. The total f value for this transition is then 0.15. Absolute excitation cross sections for the first five vibrational levels ($v' = 0 \rightarrow 4$) of the $A\ ^1\Pi$ state were determined for each parent gas using the measured cross sections of specific bands and the absolute transition probabilities. When CO was the parent gas, the relative populations of these vibrational levels were proportional to the Franck–Condon factors, $q_{v'0}$. The sum of the cross sections for these levels is 1.87×10^{-17} $cm^2 \pm 15\%$ at 300 eV. This represents 87.4% of the total excitation cross section for the $A\ ^1\Pi$ state. The relative populations of the first five vibrational levels were also determined for dissociative excitation of CO_2, and they differed from the relative populations that resulted from direct excitation of CO. The sum of the cross sections for these five levels is 1.4×10^{-18} $cm^2 \pm 17\%$ at 300 eV. (auth)

22369 EMISSION FROM LONG-LIVED STATES IN ION BEAMS. NEW BAND SYSTEMS OF NO^+. Maier II, William B.; Holland, R. F. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 54: 2693-2714(15 Mar 1971).

A method for investigating radiation from long-lived, excited states of ions is described. Emission spectra, apparent lifetimes of the excited states, and electron impact cross sections for producing the radiation can be studied. The spectrum of emission from long-lived states of NO^+ in an ion beam was obtained for wavelengths between 1250 and 2200 Å, but no NO^+ emissions were observed in spectral scans of the 2200- to 3400-Å region. Some of the spectral features are produced by transitions of the $X\ ^1\Sigma^+$ state of NO^+ from the $v' = 0$ and 1 levels of a single electronic state having an internuclear distance $1.157^{+0.02}_{-0.01}$ Å and an apparent lifetime 135 ± 35 μsec. These two vibrational levels are 7.301 ± 0.006 and 7.511 ± 0.01 eV above the ground state of NO^+. The other emissions observed can be characterized by two apparent lifetimes, 10.8 ± 2 and 160 ± 50 μsec, and appear to be produced by transitions to the $X\ ^1\Sigma^+$ state from several upper states. Tentatively, the energies of the upper states are set at 9.639 ± 0.006, 9.437 ± 0.009, and 9.232 ± 0.006 eV above the ground state of NO^+. Other radiating levels may be at 9.34, 9.07, and/or 8.79 eV. Some of the observed radiation may be produced by the previously reported $A^1\pi \rightarrow X^1\Sigma^+$ transitions, where the $A^1\pi$ state would have to be populated by a slow cascade. (auth)

22370 REACTIONS BETWEEN H^+ AND D_2. Maier II, William B. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 54: 2732-9(15 Mar 1971).

Cross sections were measured for the production of D_2^+, HD^+, and D^+ in reactions between H^+ and D_2. The initial kinetic energies E_{cm} in the center-of-mass system are between 0.3 and 80 eV. The total cross section σ_T for these reactions can be represented by $\sigma_T = 1.54\ E_{cm}^{-0.7}$ for $8 \leq E_{cm} \leq 80$ eV, and $\sigma_T = 2.11\ E_{cm}^{-1.43}$ for $0.3 \leq E_{cm} \leq 2$ eV, where σ_T is in square angstroms, and E_{cm} is in electron volts. Apparent thresholds for the endothermic reactions $H^+ + D_2 \rightarrow D_2^+ + H$ and $H^+ + D_2 \rightarrow HD^+ + D$ are found at $E_{cm} = 1.84 \pm 0.3$ eV. The cross section for $H^+ + D_2 \rightarrow D^+ + HD$ drops rapidly with increasing energy. For $E_{cm} \gtrsim 6$ eV, D^+ appears to be produced mostly by the reaction $H^+ + D_2 \rightarrow D^+ + D + H$. When $E_{cm} \gtrsim 8$ eV, the reaction products are primarily D_2^+ and a smaller amount of D^+. There is only fair agreement between these results and those of previous studies. (auth)

22371 ON A RELATION BETWEEN UNITARY TRANSFORMATIONS IN THE IMPACT PARAMETER APPROXIMATION WHICH DESCRIBES THE BEHAVIOUR OF THE ELECTRONS BEFORE AND AFTER THE TRAJECTORY CROSSES THE TURNING POINT. Lebedeff, S. A. (Queen's Univ., Belfast). J. Phys., B (London: 4: 42-52(Jan 1971).

A relation is derived between unitary transformations in the impact parameter approximation or in the classical path method. The unitary transformations describe the behavior of the electrons before and after the trajectory, which is followed by heavy particles, crosses the turning point. The properties used to establish the relation are the assumption that the trajectory of heavy particles is determined by a spherically symmetric potential as well as the invariance of the Hamiltonian under rotation and the time inversion invariance. To facilitate the use of this relation an additional relation is derived using the fact that a trajectory determined by a spherically symmetric potential is constrained to a plane. (auth) (UK)

22372 ELASTIC EXCHANGE SCATTERING OF ELECTRONS ON THE HYDROGEN ATOM IN THE DISTORTED-WAVE APPROXIMATION. Shelton, W. N. (Florida State Univ., Tallahassee); Baluja, K. L.; Watson, C. E. J. Phys., B (London): 4: 71-8(Jan 1971).

Angular distributions of electrons resulting from exchange scattering on the ground state of the hydrogen atom are calculated in the distorted-wave approximation in the energy range 1 to 50 rydbergs. Comparison is made with various plane-wave approximations and with the close-coupling calculations of Burke, Schey, and Smith (1963). It is found that the distorted-wave results are in much better agreement with the close-coupling calculations than are the plane-wave results. It is also found that inclusion of a static polarization potential does not greatly affect the distorted-wave results in this energy range. (auth) (UK)

22373 APPROXIMATION METHODS IN THE SCATTERING OF FAST ELECTRONS AND POSITRONS BY HYDROGEN ATOMS. Garibotti, C. R.; Massaro, P. A. (Univ., Bari, Italy). J. Phys., B (London): 4: 79-87(Jan 1971).

The usefulness of three methods of approximation that include second-order effects for the calculation of intermediate- and high-energy scattering cross sections is studied. They are tested in potential scattering and then are applied to the elastic scattering of electrons and positrons by hydrogen atoms, including as second-order corrections the transition through the 1s, 2s, and 2p intermediate states. It is found that the Padé method is reliable over a wider energy range, and inconsistencies are shown in the third-order approximation usually employed in the evaluation of $e^{\pm}-H$ scattering. (auth) (UK)

22374 FORMATION OF H^+ FROM H^- IONS BY ELECTRON IMPACT. Peart, B.; Walton, D. S.; Dolder, K. T. (Univ. of Newcastle upon Tyne, Eng.). J. Phys., B (London): 4: 88-93 (Jan 1971).

Cross sections of the reaction $H^- + e \rightarrow H^+ + 3e$ were measured for interaction energies between threshold (14.4 eV) and 850 eV. The cross section reaches a maximum value 5.0×10^{-17} cm^2 at 70 eV. Comparison with previous measurements shows that, for energies greater than 100 eV, the ratio of cross sections for single and double detachment is almost constant and equal to $39 \pm 10\%$. The present measurements are compared with similar results for helium and Li^+. (auth) (UK)

22375 COLLISIONAL DESTRUCTION OF FAST METASTABLE HYDROGEN ATOMS. Gilbody, H. B.; Browning, R.; Reynolds, R. M.; Riddell, G. I. (Queen's Univ., Belfast). J. Phys., B (London): 4: 94-105(Jan 1971).

A modulated-beam technique was used to investigate the collisional destruction of 10- to 30-keV 2s metastable hydrogen atoms in passage through hydrogen, helium, neon, argon, krypton, and nitrogen. It is shown that, at the impact energies investigated,

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both electron loss and de-excitation are significant destruction processes and the absolute cross sections for each process were separately determined. Loss of cross sections for metastable atoms, which were found to be approximately a factor of two larger than the corresponding cross sections for ground-state hydrogen atoms, are compared with recent theoretical estimates obtained by Bates and his collaborators (1969) using a classical impulse approximation. The formation of metastable atoms by charge-transfer neutralization of 10- to 30-keV protons was also analyzed quantitatively using neutralizer gas pressures high enough to obtain equilibration of the beam. (auth) (UK)

Atomic Theory

Refer also to abstract 22654.

Cosmic Radiation

Refer also to abstracts 21440, 21442, 22348, 22406, 22663, 22664, 22754, and 22777.

22376 PRIMARY COSMIC-RAY ELECTRON SPECTRUM BETWEEN 5 AND ≈ 300 GeV IN 1968. Scheepmaker, A. (Kamerlingh Onnes Laboratorium, Leiden); Tanaka, Y. Astron. Astrophys; 11: 53-6(Mar 1971).

Balloon observations in 1968 with an electron detector, carried out from Gap, France (cut-off rigidity 5.3 GV), resulted in a determination of the energy spectrum of primary electrons between 5 and ~300 GeV. The spectrum fits a single power law in this energy range of: $dN/dE = 1.27 \times 10^{-2} \times E^{-2.7\pm0.1}$ electrons cm^{-2} s^{-1} sr^{-1} GeV^{-1}. (auth)

22377 ELECTROMAGNETIC INTERACTIONS IN ASTROPHYSICS: ACCELERATION PROCESSES. Schatzman, E. (Institut d'Astrophysique, Paris). J. Phys. (Paris), Colloq.; C3: 8-13 (Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

A brief review is presented of acceleration processes. Following a reminder of observational facts, the thermodynamics of cosmic rays (energy conservation, entropy, production) is considered, with the conclusion that acceleration processes naturally belong to electromagnetic interactions. Stochastic processes are schematically presented, either as a particle–wave interaction (Tsytovitch), or as a random process (Frisch). Global processes, neutral-line discharges (Syrovatskii), or supernovae explosions (Ginzburg) are presented as generators of beam instabilities, yielding a plasma turbulence, which in turn generates the acceleration (Tsytovitch). A simple thermodynamics (Syrovatskii) explains the production of a power-law spectrum. (auth)

22378 HIGH-ENERGY COSMIC RAYS. Peters, B. (Danish Space Research Inst., Copenhagen). J. Phys. (Paris), Colloq.; C3: 94-101(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

The properties of high-energy cosmic-rays are used to discuss the possible existence of new particles and the behavior of "fireballs." The problems of the possible occurrence of antimatter in galactic cosmic rays, of its confinement in the Galaxy, and of its relationships with neutron stars are considered. (auth)

22379 ELEMENTARY PARTICLES AND COSMIC RADIATION. Le Bellac, M. (Physique Theorique, Nice). J. Phys. (Paris), Colloq.; C3: 111-18(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

The experimental and theoretical knowledge of the properties of fundamental particles has allowed recently interesting applications in the domain of cosmic-ray physics. A first example is the cut-off of the cosmic-ray spectrum above 10^{20} to 10^{21} eV due to the 1,238-MeV π-nucleon resonance (Δ resonance). Because of this resonance, the cross section for π-meson photoproduction ($\gamma p \rightarrow \pi^0 p$, $\pi^+ n$) rises very rapidly above threshold; very energetic protons are then slowed down by collisions with the photons of the universal blackbody radiation at 3°K. The Δ-resonance has also a very important influence on the production of γ rays of energy $\lesssim 1$ GeV in cosmic-ray collisions with particles of the interstellar or intergalactic gas. At the highest energies at present available with accelerators, it seems that only resonances with isospin $\frac{1}{2}$ are produced with a nonrapidly decreasing cross section in quasi-2-body reactions: the mechanism of diffraction dissociation, or exchange of the Pomeranchuk pole (in the Regge-pole theory) is able to explain this result, and shows that it must remain true at higher energies. Stecker has used this result to estimate the production of γ-rays with energies $\gtrsim 10^4$ GeV in p–p collisions. Another application is the model proposed by Adair for the propagation of cosmic rays in the atmosphere: Adair assumes that in p–p collisions, two fire balls are produced, having the proton internal quantum numbers, and that this production is controlled by the exchange of the Pomeranchuk pole. (auth)

22380 MEASUREMENT OF COSMIC-RAY ELECTRONS. Agrinier, B. (CEN, Saclay, France). J. Phys. (Paris), Colloq.; C3: 119-25(Nov-Dec 1969). (In French).

From Conference on Fundamental Physics and Astrophysics, Nice, France. See CONF-690449.

The electrons have special energy loss mechanisms as synchrotron radiation, bremsstrahlung, and inverse Compton effects. In this regard, cosmic-electron research gives important scientific data on the interstellar medium. To date, research has been strongly developed in two ways: energy spectrum measurement and charge sign recognition. (auth)

22381 COSMIC-RAY INTENSITY DECREASE OF SEPTEMBER 23, 1966. Desai, U. D. (Goddard Space Flight Center, Greenbelt, Md.). Can J. Phys.; 49: 265-9(15 Jan 1971).

Earlier studies have interpreted the Forbush decrease of Sept. 23, 1966 in terms of two phases; an initial predecrease and a later worldwide decrease. This interpretation precluded the possibility of correlation with a concurrent magnetic storm and led to an explanation of the predecrease (Mathews et al. 1968) in terms of a shadow cast by a distant plasma cloud approaching from a direction 85° to the west of the Sun–Earth line. In the present study, particle and magnetic-field data from satellite-borne detectors and ground-based neutron monitors clearly show the onset of the Forbush decrease coincident with the SSC magnetic storm. It is pointed out that the Forbush decrease arises from a corotating shock front approaching from the east of the Sun–Earth line and is not associated with any solar-flare effect. Further, the increases observed by the various neutron monitors 9 hr after the onset of the Forbush decrease are interpreted to be an enhancement of the diurnal anisotropy. An example of an increase in intensity in the IMP-3 detector arising from electron contributions is also pointed out. (auth) (Canada)

22382 INTENSITIES OF LOW-ENERGY COSMIC-RAY ^{2}H AND ^{3}He NUCLEI MEASURED IN 1967–1968. Baity, W. H. (Goddard Space Flight Center, Greenbelt, Md.); Teegarden, B.; Lezniak, J. A.; Webber, W. R. Astrophys. J.; 164: 521-7(15 Mar 1971).

Measurements of the intensities of ^{2}H and ^{3}He made by two different instruments carried respectively on the Pioneer 8 and IMP IV spacecraft are presented. The results from these two quite different instruments were found to be in good agreement. The ^{3}He results are consistent with published results of other observers. The ^{2}H results are consistent with measurements at solar minimum when modulation is taken into account. The values for the ^{2}H intensity, however, disagree with those of Hsieh and Simpson taken in late 1967. This discrepancy cannot be explained at present. The implications of these results with respect to the solar modulation and galactic propagation of cosmic rays are discussed. (auth)

22383 POLARIZATION CHARACTERISTICS OF 42-MHz AURORAL BACKSCATTER. Sofko, G. J.; Kavadas, A. (Univ. of Saskatchewan, Saskatoon). J. Geophys. Res.; 76: 1778-92(1 Mar 1971).

During April and May 1964, a time-sharing polarimeter at Saskatoon made rapid recordings of the complete polarization state of 42-MHz oblique backscatter from some half-dozen strong breakup auroras. Two distinctly different types of polarization are presented here. The first type is characterized by a high polarization ratio m that increases with increasing backscatter intensity, differs significantly from the transmitted polarization, and has great diversity in the ellipticity and orientation of the received ellipses. This type appears to be associated with a type of fading that is quasi-sinusoidal with dominant frequencies in the 4- to 25-Hz range and that is associated with the early phase of breakup events. The second type of scatter is characterized by a lower polarization ratio m, which decreases as the backscatter intensity increases. The elliptically polarized portion of the second scatter is much closer to the transmitted horizontal linear polarization than in the first type. This second type displays more irregular fading and so shows higher-frequency components in its power spectrum than the first type. It is argued

that the first type arises from a limited number of strong scatterers having complex anisotropic reflection coefficients. The second type seems to arise from a large number of scatterers that are weaker and that produce largely incoherent scatter. (auth)

22384 SOLAR MODULATION OF COSMIC-RAY PROTONS, HELIUM NUCLEI, AND ELECTRONS. A COMPARISON OF EXPERIMENT WITH THEORY. Lezniak, J. A.; Webber, W. R. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 76: 1605-24(1 Mar 1971).

The galactic cosmic-ray proton and helium nuclei spectra (j) were measured aboard the Pioneer 8 spacecraft over a large energy range. These data are compared with spectra measured near solar minimum (j_{1965}), and the modulation parameter $M \equiv \beta \ln (j_{1965}/j)$ is calculated. A similar comparison is made for published electron spectra. The modulation parameters for all the components are observed to increase to a maximum and then to begin to decrease at low energies. At the same rigidity a splitting dependent on the charge-to-mass ratio (or, equivalently, the velocity) is observed for protons, helium nuclei, and electrons. This splitting is not in accord with the predictions of the simple diffusion–convection model. Numerical solutions of the complete transport equation, which includes the process of adiabatic deceleration together with the processes of diffusion and convection, are considered. Assumptions under which spectra and time variations can be generated are in reasonable agreement with the observations. (auth)

22385 INTENSITY AND ENERGY SPECTRUM OF ENERGETIC COSMIC-RAY ELECTRONS. Marar, T. M. K.; Freier, Phyllis S.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). J. Geophys. Res.; 76: 1625-36(1 Mar 1971).

The intensity and energy spectrum of cosmic-ray electrons with $E \geq 5$ GeV were studied by using a nuclear emulsion-spark chamber combination detector triggered by scintillation and Cherenkov counters. This detector was flown on a high-altitude balloon launched from Palestine, Texas, on September 19, 1967, at 3.0 ± 0.2 gm/cm^2 residual atmosphere. The response of this detector was examined with a Monte Carlo calculation developed to study the generation of an electromagnetic shower in emulsions. The integral intensity of electrons of $E \geq 10$ GeV, obtained from the emulsion analysis of showers observed in the spark chamber, is $0.15 \pm {}^{0.1}_{0.07}$ electrons/m^2 ster sec, a factor of ≃10 lower than the commonly accepted value of ≃2 electrons/m^2 ster sec. Hence, as an independent determination, a line scan was made of the vertical emulsions at a depth of 1.4 radiation lengths to detect high-energy electromagnetic showers. In addition, horizontal emulsions sandwiched between lead plates mounted below the emulsion block were scanned to look for large showers produced by particles within a restricted geometry. Integral intensities in the energy range 5 to 20 GeV obtained from the line scan agree with the results of some other workers but are still not as high as the commonly accepted values. The measured integral intensity at $E \geq 10$ GeV is 0.55 ± 0.19 electrons/m^2 ster sec. The use of an anticoincidence counter in this detector is believed to have been the cause of the discrepancy between the spark chamber and the direct scan results. The atmospheric γ-ray intensity was measured under 3.5 gm/cm^2 equivalent atmosphere and provides a verification of the electron results from the line scan. The consequences of such a lower intensity of electrons are discussed in relation to some astrophysical problems. (auth)

22386 COSMIC RAYS AT HIGH LATITUDES AND ALTITUDES COVERING FOUR SOLAR MAXIMA. Neher, H. V. (California Inst. of Tech., Pasadena). J. Geophys. Res.; 76: 1637-51(1 Mar 1971).

Since 1937 balloon flights have been made in which instruments measuring cosmic rays were carried to high altitudes at high latitudes. The earlier flights involved only the years 1937, 1938, 1940, and 1946, but since 1951 only 1952 and 1953 have been missed. The instruments used were ionization chambers that were compared with standards kept at Pasadena. Checks on absolute values of ionization at intervals indicate that experimental results over the 32-year period can be closely compared. In addition to giving a summary of already published results, data from balloon flights at Thule for the years 1966 through 1969 are presented for the first time. In comparing cosmic rays at high altitudes during the 1930's with similar measurements in the 1960's, it is shown that the intensity of cosmic rays was at least 10% higher at 20 gm cm^{-2} during the earlier periods for similar solar activity. It is suggested that this long-term modulation effect probably takes place where the solar wind encounters the interstellar medium and may be determined by the average solar activity of several preceding solar cycles. (auth)

22387 INCREASES IN THE LOW-ENERGY COSMIC-RAY INTENSITY AT THE FRONT OF PROPAGATING INTERPLANETARY SHOCK WAVES. Fisk, L. A. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: 1662-72(1 Mar 1971).

A simple mechanism is considered for producing the pulse-like increases in the low-energy cosmic-ray intensity (0.3 to 5 MeV/nucleon) that occur at the front of propagating interplanetary shock waves. It is assumed that low-energy particles are swept up by the shock, but because of extensive scattering by magnetic field irregularities, the particles remain near the shock front forming the pulse. The behavior of the particles in the vicinity of the shock is discussed in terms of a simple one-dimensional model in which the particles undergo convection and diffusion, and in which they can gain energy by making repeated collisions with the moving shock front, or with the magnetic irregularities directly behind the shock. The spectrum at energies ≲1 MeV/nucleon is found to be harder at the shock front than it is for the ambient particles ahead of the shock, which is in agreement with some observations. The width of the pulses can be used to estimate the magnitude of the local low-energy diffusion coefficient, and the predicted pulse shapes agree reasonably well with the observations, provided that the diffusion coefficient parallel to the magnetic-field lines is ~10^{19} cm^2/sec for 1-MeV protons. (auth)

22388 RADIATIVE TRANSFER OF ISOTROPIC X-RAYS AND GAMMA RAYS. I. GENERAL THEORY AND SOLUTIONS FOR A UNIFORM MEDIUM. Arons, Jonathan (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 164: 437-55 (15 Mar 1971).

An equation is found for the transfer of isotropic γ rays of energy $\epsilon \geq 2$ MeV in a medium whose temperature satisfies the condition $kT \ll \epsilon$. The redistribution of the radiation in energy due to Compton scattering is included. This equation is solved to lowest order in mc^2/ϵ by a Green's function technique for the case of an infinite homogeneous medium. The general solution is applied to three cases: (1) the relaxation in time of a monochromatic burst of γ rays; (2) the relaxation of a power-law burst of γ rays; (3) the formation of the γ-ray spectrum produced by a steady, monochromatic source. An energy diffusion equation for isotropic x rays of energy $\epsilon \lesssim 150$ keV is also found. The radiative transfer of such x rays is shown to be qualitatively similar to the effects of inverse Compton scattering on ultrarelativistic electrons interacting with soft photons. A general solution of the x-ray equation is used to discuss the further softening of γ rays that have been reduced to x ray energies by Compton scattering. Some possible applications to supernovae are discussed qualitatively. (auth)

22389 RADIATIVE TRANSFER OF ISOTROPIC X-RAYS AND GAMMA RAYS. II. HIGH ENERGY RADIATION IN THE EXPANDING UNIVERSE. Arons, Jonathan (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 164: 457-68(15 Mar 1971).

Equations of radiative transfer for isotropic x rays and γ rays propagating in an infinite, homogeneous, Compton-scattering medium were derived in the accompanying paper. These equations are extended here to include the effects of the cosmological expansion on isotropic high-energy radiation propagating in the intergalactic medium. The resulting equations are solved in the limits $\epsilon \ll mc^2$ and $\epsilon \gg mc^2$, where $\epsilon = h\nu$. The solutions show that the x-ray background could not have been produced earlier than a redshift $z \approx 10$ if the number density of intergalactic hydrogen is $n_H^{(0)} \gtrsim 5 \times 10^{-6}$ cm^{-3}. The heating and ionizing effects of the fast electrons produced by Compton scattering are shown to be insufficient to explain the observed upper limits on the density of intergalactic neutral hydrogen. (auth)

22390 COSMIC-RAY INTENSITY VARIATIONS IN THE LOWER ATMOSPHERE. Kent, D. W.; Pomerantz, M. A. (Bartol Research Foundation Swarthmore, Pa.). J. Geophys. Res.; 76: 1652-61(1 Mar 1971).

Worldwide cosmic-ray intensity measurements at aircraft altitudes were made over a solar cycle. Data obtained with a neutron monitor aboard the U.S. Naval Oceanographic Office Project Magnet aircraft during different epochs were compared to determine the long-term variation of the nucleonic intensity at latitudes ranging from north to south geomagnetic poles. The measurements were normalized to a constant pressure–altitude, 500 mm of Hg, on the basis of experimentally determined time- and rigidity-dependent attenuation coefficients. Between October 1958 and January 1965, the intensity increased 8.7% at a rigidity of 17 GV, and 20.9% at 2 GV. The measured intensities as a function of threshold rigidity are in good agreement with the predictions of trajectory calculations based on a sixth-degree simulation of the geomagnetic field. At solar minimum, measurements of

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the latitude effect were also obtained for five groups of multiple events and for mesons; the highest group, multiplicity $K \geq 6$, varies less with latitude than do the mesons. The latitude effect for $K = 3$ is intermediate between that for the neutron total counting rate and the meson counting rate. The attenuation length for mesons is found to vary with altitude in reasonable agreement with the predictions of Wada [1960]. (auth)

22391 SPECTRUM OF THE 11-YEAR COSMIC-RAY VARIATION IN 1965–1969, ACCORDING TO THE RESULTS OF SOVIET LATITUDINAL EXPEDITIONS. Dorman, I. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 564-5 (1970).

Translated from Geomagn. Aeron.; 10: 718(1970).

The spectrum of the 11-year variation and its change in the course of the 19th solar-activity cycle were found from the results of Soviet latitudinal expeditions. In order to determine whether the 20th cycle follows the same pattern, the spectra of global modulation were determined from measurements of 1965 (western USSR), 1966 (eastern USSR), and 1968 and 1969 (along the Baltic–South America traverse). Results show that the main patterns established for the 19th cycle can be extended to the 20th cycle; the power-law-like spectrum, the tendency of the exponent α to increase with R, and some change in α with solar activity. (J.C.W.)

22392 INTENSITY FLUCTUATIONS OF GALACTIC COSMIC RAYS. Shishov, V. I. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 459-63(1970).

Translated from Geomagn. Aeron.; 10: 582-7(1970).

The possibility of observing the intensity fluctuations of galactic cosmic rays produced by the scatter of cosmic rays on inhomogeneities of the interplanetary magnetic field is examined. Relationships are obtained that associate the temporal spectrum of the intensity fluctuations of cosmic rays with the spatial spectrum of the inhomogeneities of the interplanetary magnetic field. (auth)

Direct Energy Conversion

22393 (N-70-42201) CHARACTERISTICS OF A THERMIONIC CONVERTER WITH A CHLORIDE VAPOR DEPOSITED TUNGSTEN EMITTER (110) AND A COLLECTOR OF MOLYBDENUM DEPOSITED ON NIOBIUM. Wilson, V. C.; Podkulski, S. P. (General Electric Co., Schenectady, N. Y.). Oct 1970. Contract NAS3-8511. 48p. (NASA-CR-1699; GESP-9011). NTIS.

A parallel-plane, variable-spaced laboratory thermionic converter consisting of a chloride-vapor-deposited tungsten emitter of (110) crystal orientation and a collector of molybdenum surface layer deposited on a niobium base was built and tested. Current–voltage characteristics were obtained for a range of emitter temperatures from 1650 to 2035°K, collector temperatures from 993 to 1023°K, cesium reservoir temperatures from 573 to 653°K, and interelectrode spacings from 5 to 20 mils. Post-test analyses show the collector surface to be molybdenum and niobium. The collector thermionic characteristics are primarily those of niobium. (auth) (STAR)

22394 (N-70-42733) CASCADED THERMOELECTRIC TEST GENERATOR. Final Report. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). 25 Sep 1970. Contracts NAS7-100; JPL-952196. 102p. (NASA-CR-110877; WANL-PR(DDD)-6). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

A two-stage cascaded thermoelectric test generator was designed and fabricated. The design is based on state-of-the-art thermoelectric technology and represents an integration of three proven engineering devices into a compact space power supply test system. The generator consists of a high-temperature silicon–germanium stage thermally coupled to a lead-telluride tubular-module stage by a sodium heat pipe. A high-temperature tantalum electrical heater was designed to thermally simulate a radioisotope heat source. The generator, heat source, and a calorimetric heat sink were assembled within a vacuum chamber. The design efficiency goal for the cascaded unit is a minimum of 7%. It is anticipated that the test assembly will demonstrate an overall efficiency of at least 8.8% and generate 213 watts of electrical power at reference operating conditions. (auth) (STAR)

22395 NUMERICAL CALCULATIONS OF THE ELECTRICAL PARAMETERS IN A FARADAY-TYPE MHD GENERATOR WITH TWO-DIMENSIONAL GAS FLOW. Celinski, Z. (Inst. of Nuclear Research, Swierk, Poland). Arch. Elektrotech. (Warsaw); 19: 771-85(1970).

When the gas parameters are nonuniformly distributed in the channel cross section of the MHD generator, its electrical performance deteriorates considerably. A two-dimensional electrical network was used as a model of the two-dimensional gas flow in the MHD channel. Applying the calculated velocity and temperature profiles, the network was solved using the GIER computer. All electrical values, the terminal ones as well as local, were calculated. A constant-channel cross section subsonic gas flow, and uniform distribution of the gas parameters along the channel were assumed in the calculations. The distribution of the gas parameters was assumed to be independent of the generator loading. The channel end effects were neglected. (auth)

22396 LEAKAGE CURRENTS IN AN MHD GENERATOR. Celinski, Z. (Inst. of Nuclear Research, Swierk, Poland). Arch. Elektrotech. (Warsaw); 19: 753-67(1970).

The effect of leakage currents upon the MHD generator performance was analyzed. There are two main paths for the leakage currents: through the side insulating walls and through the generator casing. The poor performance of the experimental Hall generators is due to the leakage to the generator casing. If only leakage currents through the side walls are present they deteriorate the output power in the Faraday generator more than in the Hall one. The analysis assumed constant channel cross section, constant magnetic field, and constant gas parameters in the channel. (auth)

22397 EXPERIMENTAL STUDY OF AN MHD GENERATOR USING A NOBLE GAS–ALKALI-METAL PLASMA AS WORKING MEDIUM. Denzel, P.; Munkel, J.; Stratmann, J. Elektrotech. Maschinenbau; 86: 494-8(Nov 1969). (In German).

Experiments with a small MHD generator using argon are described. The results are published for approximately 20 experiments of 30-minutes duration each. Voltage–current characteristics for various pairs of electrodes are shown, and the variation of internal resistance as a function of magnetic flux density is tabulated. To obtain the internal resistance for high current densities, some experiments use an external voltage source together with the induced voltage. (App. Mech. Rev.)

22398 BEHAVIOR OF A LARGE NONEQUILIBRIUM MHD GENERATOR. Decher, Reiner (Univ. of Washington, Seattle); Hoffman, Myron A.; Kerrebrock, Jack L. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: 357-64(Mar 1971).

A large nonequilibrium MHD generator of the linear, segmented-electrode, Faraday type was studied both experimentally and theoretically. Experiments were run at the following nominal operating conditions: generator Mach number of 2.2 with a mass flow of 0.4 kg/sec^{-1} of helium seeded with about 0.3% cesium; stagnation conditions were 2000°K and about 5-atm pressure. The loaded generator exhibited several unusual features, including a very slow increase in the load currents axially and very large anode drops. The Hall voltage was a small fraction of its ideal value. At short circuit, load currents at least five times those possible with frozen ionization were drawn; but these currents were still far below those predicted by one-dimensional theory. At open circuit, the transverse voltages were usually very low near the inlet and exit but as large as 0.6 of the ideal value near the channel center; negative electrode drops were measured on both cathodes and anodes. A theoretical model is proposed to explain this behavior. It is hypothesized that highly conducting layers exist along the electrode walls that short the generator through the end regions at open circuit. These layers exist because the transverse current is impeded at the insulator segments of the electrode wall, leading to a larger conductivity there than in the main flow. Under load these layers interact with a two-dimensional inlet relaxation front to couple the generator end-to-end, producing the very slow axial buildup of the load current. The proposed model is shown to explain the major features of the experimental results. (auth)

Fluid Physics

Refer also to abstract 22341.

22399 MAGNETOHYDRODYNAMIC WAVES IN A CIRCULAR CYLINDER OF FINITE LENGTH. Vacca, M. T. Rend. Ist. Lombardo Sci. Lett., A; 103: 183-98(1969). (In Italian).

Magnetohydrodynamic waves are studied for an incompressible fluid with infinite electrical conductivity in a circular cylinder of finite length, under action of a uniform axial magnetic field; non-electromagnetic forces are assumed, deriving from a potential U. Introducing the function $P = p/\rho - U$ (p, ρ pressure and density of

the fluid), it is shown that the velocity and P satisfy nonhomogeneous wave equations, where the right members depend on the same harmonic function f; periodic solutions are calculated with the method of the arbitrary constants variation. In cylindrical coordinates (r,z,θ), and assuming that the harmonic function f depends on U through the factor $\exp\{in\theta\}$ $(n\epsilon N^+)$, an equation is obtained which is studied using the method of separated variables; solutions are given in terms of Bessel functions of the first kind, with $k_n r$ for argument. Autovalues of k_n and of the pulsation are determined, considering boundary conditions for the velocity and induced magnetic field, respectively. The particular case is also examined where function f is independent of $\theta(n = 0)$. (App. Mech. Rev.)

22400 GENERATION OF HIGHLY TURBULENT FLOWS. Savulescu, St. N.; Toma, V. Rev. Roum. Sci. Tech., Ser. Mecan. Appl.; 14: 1087-1114(1969). (In French).

The experimental results of highly turbulent flows from interacting a principal flow with several transverse jets are presented. Domains of highly turbulent flows are obtained in two devices of original design (turbulence generators). Information on their behavior as compared to the ideal case of a highly turbulent flow as well as on the correlation between the geometric and kinematic variables involved is presented. (auth) (Rom. Sci. Abstr.)

22401 EFFECT OF CONDUCTING WALLS ON THE DISPERSION OF SOLUBLE MATTER IN MHD CHANNEL FLOW. Soundalgekar, V. M. (Indian Inst. of Tech., Bombay); Gupta, A. S. Rev. Roum. Phys.; 15: 811-14(1970).

The effect of wall conductivity on the dispersion of soluble matter in MHD channel flow subject to a uniform transverse magnetic field is studied. The laminar pressure flow of an electrically conducting liquid between two infinite parallel conducting plates is considered. It is pointed out that, in MHD channel flow problems with electrically conducting walls, all the flow characteristics depend on the composite wall conductivity parameter and thus, the dispersion coefficient will not change if the two walls are interchanged. (M.H.R.)

Geophysics (Upper Atmosphere)

Refer also to abstracts 21482, 22348, and 22390.

22402 (LA-tr-71-11) NOCTURNAL IONOSPHERIC F LAYER IN THE INTERTROPICAL ZONE AND ITS RELATION TO THE EMISSION OF THE 6300 A LINE OF THE NIGHT SKY. Barbier, Daniel; Glaume, Jeannine. Translated for Los Alamos Scientific Lab., N. Mex., from Planet. Space Sci.; 9: 133-48(1962). 19p. Dep. NTIS.

Observational facts related to the properties of the ionospheric F layer and to the night-glow in the intertropical region are mentioned, and a relationship is established between the intensity of the red line on one hand and f_0F and $h_{F'}$ on the other hand. The formula is used for discussing the properties of the two zones of increased 6300-Å emission located on both sides of the magnetic equator. (auth)

22403 (N-70-42935) FORTRAN PROGRAMS FOR CALCULATING LOWER IONOSPHERE ELECTRON DENSITIES AND COLLISION FREQUENCIES FROM ROCKET DATA. Mechtly, E. A.; Monro, P. E.; Golshan, N.; Sastry, R. S. (Illinois Univ., Urbana. Aeronomy Lab.). 1 Jul 1970. 62p. (NASA-CR-110899; UILU-ENG-70-260). NTIS.

A record and discussion are given of computer programs used for calculating D- and E-region electron densities and collision frequencies from Faraday-rotation, differential-absorption, and standing-wave data obtained from Nike-Apache rocket radio-propagation experiments. All the programs are written in FORTRAN 4 and are compatible with the IBM 360 system. (auth) (STAR)

22404 SOME FORMULAS FOR PCA IONIZATION. Velinov, P. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 1075-7(1970).

Formulation for the electron-production rate during PCA events is obtained by utilizing the range-energy ratio of solar cosmic rays spirally penetrating into the polar atmosphere. The method differs from the determination described by Velinov, but is similar to the method for the determination of the energy dissipation of spiraling particles elaborated by Maeda and Singer. (J.C.W.)

22405 EXPERIMENT WITH EXPONENTIAL MODEL FOR IONOSPHERIC D REGION. Nestorov, G. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 1079-82(1970).

An exponential model of the D region based on experimental data is given. Measurements at Sofia during June 1969 were used. The N(h) profiles were obtained, and from these, other parameters of the D region at various heights were calculated, including disturbances. The application of the exponential model for vertical distribution to the D region illustrates the possibilities of supplying aeronomic information about the parameters of the region and the composition of the ionization-neutralization and energy balance. The model allows for a continuous checkup of the D-region ionization. (J.C.W.)

22406 INVESTIGATION OF COSMIC RAYS AND RADIATION BELTS BY A VERTICAL SPACE PROBE. Vernov, S. N.; Vakulov, P. V.; Kuznetsov, S. N.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 8: 374-82(May-Jun 1970).
Translated from Kosm. Issled.; 8: 408-17(May-Jun 1970).

Results obtained with a vertical space probe launched on October 12, 1967 are reported. The height variation of cosmic rays on the magnetic shells $1.7 < L < 2.2$ was obtained, the multiplication factor of cosmic rays was determined for the case of a counter placed on the surface of the vehicle, and a pronounced anisotropy in the albedo flux of cosmic rays was discerned. The electron spectrum on the magnetic shells $2 < L < 3$ in the radiation belts encircling the Earth was measured; the pitch-angle distribution of electrons such that $E_e > 40$ keV on the magnetic shells L = 2.2, 2.6, and 3.0 was studied; and a rise in the flux of escaping electrons with increasing L was discovered. (auth)

22407 INTERPLANETARY PLASMA DISTURBANCES NEAR VENUS DETERMINED FROM VENERA-4 AND VENERA-6 DATA. Gringauz, K. I.; Bezrukikh, V. V.; Volkov, G. I.; Musatov, L. S.; Breus, T. K. Cosmic Res. (USSR) (Engl. Transl.); 8: 393-7(May-Jun 1970).
Translated from Kosm. Issled.; 8: 431-6(May-Jun 1970).

Simultaneous disturbances of interplanetary plasma and the magnetic field were discovered on October 18, 1967, during approach of the Venera-4 space probe to the planet Venus, by means of the charged-particle traps and magnetometer carried aboard. The preliminary results of Venera-4 plasma measurements were reported previously. On May 17, 1969, similar changes in plasma fluxes near Venus were discovered during approach of the Venera-6 probe to that planet; this probe also carried a charged-particle trap. These observations, together with data on interplanetary-plasma disturbances obtained on October 19, 1967, near Venus by Mariner 5, make it possible to assert with greater assurance than before that solar-wind disturbances always exist near Venus and cannot be attributed to interplanetary-plasma inhomogeneities randomly present near the planet on October 18, 1967, during approach of Venera-4. The corrected results of processing of plasma measurements made near the planet on Venera-4, and preliminary results of plasma measurements made near the planet on Venera-6 are discussed. (J.C.W.)

22408 HIGH-ENERGY ELECTRONS IN CIRCUMTERRESTRIAL SPACE. Grigorov, N. L.; Kalinkin, L. F.; Kogan-Laskina, E. I.; Savenko, I. A. Cosmic Res. (USSR) (Engl. Transl.); 8: 383-6(May-Jun 1970).
Translated from Kosm. Issled.; 8: 418-22(May-Jun 1970).

The composition and origin of fluxes of charged particles of excess radiation in circumterrestrial space are discussed. It can be concluded from the full range of data obtained in experiments with instrumentation carried aloft in balloons and satellites that this excess radiation contains electrons with energies greater than 10 MeV. The great temporal variations of electron fluxes observed in the stratosphere suggest that electrons of quite high energies are trapped and held for a considerable time in the Earth's magnetic field. (auth)

22409 SOME ASPECTS OF STUDYING CHARGED-PARTICLES FLUXES WITH TRAPS AND ANALYZERS. I. MODULATION TRAPS. Volkov, G. I.; Zastenker, G. N.; Kopylov, V. F.; Remizov, A. P.; Khokhlov, M. Z. Cosmic Res. (USSR) (Engl. Transl.); 8: 387-92(May-Jun 1970).
Translated from Kosm. Issled.; 8: 423-30(May-Jun 1970).

The results of computation and experimental study of the characteristics of charged-particle modulation traps are given. An important peculiarity of these characteristics is their elongation in the high-energy direction associated with the curvature of particle trajectories by the modulation grid field. With adequate diaphragming of the trap entrance window, eliminating edge effects, the computed characteristics coincide well with those measured for ions. The characteristics for electrons are considerably distorted by secondary emission from the modulation grid. It is shown that in the registry of solar-wind ion spectra the readings in the energy channels situated in the direction of lesser energies rela-

tive to the spectrum maximum can be exaggerated by many times due to the above-mentioned peculiarities. (auth)

22410 AURORAL PROTONS AND THE "RESONANCE" CONCEPTION OF A SUBSTORM. Gal'perin, Yu. I.; Gladyshev, V. A.; Gurevich, A. V.; Kuz'min, A. K.; Ponomarev, Yu. N. Kosm. Issled.; 8: 457-60(May-Jun 1970). (In Russian).

After a review of the literature data, it is concluded that the available data agree with the concept of a quasi-captured distribution of auroral protons of average energy (10 keV) over the atmosphere. The auroral protons of average energy are ejected into the atmosphere as a result of processes of diffusion of quasi-captured protons showing losses at high latitudes over the atmosphere. Thus, the auroral protons of average energy are directly related to intensity of protons in the annular current belt. There is a cleansing effect at a pitch-angle of 90° so that the intensity maximum is shifted to about 70°. An expression is given for the period of drift in a solar-magnetospheric system of coordinates as a function of particle charge and its energy. It is shown that a resonance occurs when the period of longitudinal drift is close to 24 hours. The movement of the quasi-captured ions (10 keV) is very distinctive, and accumulation of the ions in the region of the cusp is possible. The ions possess a structureless phonon spatial distribution. (TTT)

22411 ROCKET-BORNE ULTRAVIOLET SPECTROMETER MEASUREMENT OF OH RESONANCE FLUORESCENCE WITH A DIFFUSIVE TRANSPORT MODEL FOR MESOSPHERIC PHOTOCHEMISTRY. Anderson, James Gilbert. Boulder, Colo.; Univ. of Colorado (1970). 207p. University Microfilms Order No. 70-23,682.

Thesis.

An upper limit on the column density of the hydroxyl radical in the Earth's upper atmosphere was determined with a rocket-borne scanning spectrometer using resonance fluorescence techniques in the near ultraviolet. The (0−0) band of the $A^2\Sigma$-$X^2\Pi$ transition at 3064 Å was studied between 60 and 108 km under evening twilight conditions from Wallops Island, Virginia, June 27, 1969. The solar zenith angle was 92°. Particular attention is given to the problem of determining the Rayleigh scattered background to allow an accurate determination of the column emission rate from the OH molecule. An emission rate factor calculation for OH is presented which considers the rotational structure of the molecule and the effect of absorption by OH in the solar atmosphere. Using this emission rate factor the upper limit on the column density of OH is found to be 6×10^{12} cm^{-2} at 65 km, 3×10^{12} cm^{-2} at 75 km and 7×10^{11} cm^{-2} at 85 km. The dissociation rate for water vapor was calculated using a high-resolution analysis of the O_2 absorption cross section. A significant amount of H_2O dissociation is found to occur throughout the mesosphere down to the stratopause. A mesospheric oxygen−hydrogen model, which includes diffusive transport of water vapor and the recalculated H_2O dissociation rate, is considered in order to interpret the experimental results. It is demonstrated that the upper limit on the hydroxyl column density requires the eddy diffusion coefficient to be less than 1×10^7 cm^2/sec in the lower mesosphere. A model for the concentration of H, OH, HO_2, and H_2O in the mesosphere is presented using a water vapor mixing ratio of 5×10^{-6} at 50 km and an eddy diffusion coefficient of 4×10^6 cm^2/sec. (Diss. Abstr. Int., B)

22412 MOTION AND STRUCTURE OF THE MAGNETOPAUSE. Aubry, Michel P.; Kivelson, Margaret G.; Russell, Christopher T. (Univ. of California, Los Angeles). J. Geophys. Res.; 76: 1673-96(1 Mar 1971).

Data obtained during a 2-hour sequence of multiple crossings of the magnetopause in the equatorial plane near 0900 LT with the Ogo 5 UCLA triaxial fluxgate magnetometer and electron spectrometer show that the magnetopause motion was composed of two different oscillations: large-amplitude oscillations with periods from 3.5 to 6 min, and smaller amplitude oscillations with periods as short as 10 sec. The amplitude of the short-period oscillation increased abruptly when the magnetosheath field turned 90° southward, producing an extremely variable boundary. The particle boundary showed the same oscillations as the magnetic-field boundary, but the two were not coincident and their relative-position was quite variable. The direction of the normal to the magnetopause during successive crossings shows that these oscillations do not represent pulsation of the whole boundary but are ripples moving tailward with a velocity of the same order as the plasma-flow velocity. The observed structure of the boundary was not consistent with a rotational discontinuity. Since the component of the magnetic field normal to the boundary was often nonzero, however, the structure was not consistent with a steady-state tangential discontinuity either. (auth)

22413 MAGNETOSPHERIC ELECTRIC FIELD PROPERTIES DEDUCED FROM SIMULTANEOUS BALLOON FLIGHTS. Mozer, F. S. (Univ. of California, Berkeley); Manka, R. H. J. Geophys. Res.; 76: 1697-1712(1 Mar 1971).

Nearly 400 hours of ionospheric electric-field data were obtained by a series of four simultaneous balloon flights from six sites located between the plasmapause and the polar cap. Analyses of the long-term averages of these data indicate that magnetospheric electric fields and bulk plasma flow are turbulent with a scale size less than about 100 km in the ionosphere, the average equatorial electric-field strength increases with increasing Kp and is independent of altitude to within about a factor of 2 from L = 4 to 23, and its direction varies with a typical diurnal pattern. Short-term averages of these data show that this diurnal pattern is associated with magnetic bays, in that the east−west component of the ionospheric electric field in a rotating field of reference becomes westward about an hour before a bay and remains so throughout the night, while the meridional component switches from poleward to equatorward at the onset of the bay near local midnight. A previous model of the magnetospheric electric-field variation during a bay is reinforced and extended by the present observations. In this model, bays are triggered deep within the magnetosphere in the equatorial plane by an instability associated with a radial plasma density gradient. This gradient is established by the convective flow stemming from a westward electric field that exists for about an hour before the onset of the bay. The equatorward component of the ionospheric electric field that develops at the onset of the bay drives Hall currents that are largely responsible for the ground-observed magnetic variations. The electric fields implied by this model are in agreement with balloon observations in the auroral zone on a total of 17 nights, during 10 of which negative bays occurred. (auth)

22414 POYNTING FLUX STUDIES OF HISS WITH THE INJUN 5 SATELLITE. Mosier, Stephen R. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 76: 1713-28(1 Mar 1971).

Very low-frequency hiss emissions were studied in the region 677 to 2528 km and 35 to 75° invariant latitude (in the northern hemisphere) by using the Injun 5 Poynting-flux measurement technique. Downgoing elf hiss is observed over the entire region of altitude-invariant latitude space under study, whereas elf hiss having an upward-directed net Poynting flux is only observed at invariant latitudes below about 60°. A new propagation phenomenon is proposed in which downgoing elf hiss may propagate across the plasmapause boundary to lower latitudes and become subsequently reflected and trapped within the plasmasphere. Measurements indicate that at least part of the vlf hiss that is observed by the Injun 5 satellite must be generated above the Injun 5 altitude range. A new type of sub-auroral-zone vlf hiss was observed and is called midlatitude hiss. (auth)

22415 LOCATION OF GENERATION REGIONS (IN L AND λ) OF MIDLATITUDE VLF DISCRETE EMISSIONS BY DISPERSION ANALYSIS OF GROUND STATION OBSERVATIONS. Dowden, Richard L. (Univ. of Colorado, Boulder). J. Geophys. Res.; 76: 1729-37(1 Mar 1971).

Dispersion analysis of emission echoes, triggering whistlers and associated whistlers, determines the minimum gyrofrequency (and hence L shell) and the plasma density along the path for each event. These measurements and comparison with the plasmapause −Kp relationship indicate that midlatitude emissions are generated and propagate near the plasmapause, usually just inside the plasmasphere. Evidence for generation at or about the equatorial plane is that the dynamic spectrum of hook emissions is closely symmetrical about minimum frequency if the appropriate amount of path dispersion to the observer (½ or 1½ hop) is subtracted. (auth)

22416 ROCKET MEASUREMENT OF THE SECONDARY ELECTRON SPECTRUM IN AN AURORA. Feldman, P. D.; Doering, J. P.; Moore, J. H. (Johns Hopkins Univ., Baltimore). J. Geophys. Res.; 76: 1738-45(1 Mar 1971).

The differential flux of secondary electrons with energy greater than 6 eV was measured in a steady IBC I^+ aurora with an electron spectrometer aboard an Aerobee rocket. Except for the absence of structure in the energy range 10 to 20 eV, the observed spectrum is in excellent agreement with a recent theoretical prediction. About one-tenth of the observed N_2^+ emission at 3914 A can be explained by secondary electron excitation. (auth)

22417 AIRBORNE OBSERVATIONS OF AURORAL PRECIPITATION PATTERNS. Eather, R. H.; Mende, S. B. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res.; 76: 1746-55 (1 Mar 1971).

There are at least four distinct regions of auroral particle precipitation. The auroral oval and nightside proton aurora are well known; they are well separated in the evening sector and overlap in the morning sector. There is a zone of soft-electron precipita-

tion at latitudes above the auroral oval where ~0.5-keV electrons precipitate; no protons are observed in this region. Electron energies in this soft zone decrease systematically with latitude (for a given Kp). There is a zone of soft-electron (~100 to 200 eV) and soft-proton precipitation at latitudes above the auroral oval near the midday meridian, and these particles probably come directly from the magnetosheath. No higher-energy protons (as in the nightside proton aurora) were observed near midday, during quiet magnetic conditions. (auth)

22418 AURORAL LYMAN ALPHA OBSERVATIONS. 2. EVENT OF MAY 1967. Metzger, P. H.; Clark, M. A. (Aerospace Corp., Los Angeles, Calif.). J. Geophys. Res.; 76: 1756-63(1 Mar 1971).

Data are presented for a number of orbital passes of the OV1-10 (1966-111B) satellite, from which H Ly-α auroras were observed from May 18 through May 27, 1967, thus describing the largest magnetic disturbance recorded during the lifetime of this satellite. On May 25, 1967, auroral enhancements were measured corresponding to some 114 kilorayleighs or about 36 ergs cm^{-2} sec^{-1} of protons deposited in the atmosphere. For moderate magnetic disturbances, the auroral enhancements are found to correlate with the field variation at auroral latitudes such that a 100-γ variation would predict a 12-kR emission on the auroral oval near ±70°M. (auth)

22419 OBSERVATIONS AND COMPUTATIONS OF TWILIGHT HELIUM 10,830-ANGSTROM EMISSION. Christensen, A. B.; Patterson, T. N. L.; Tinsley, B. A. (Univ. of Texas, Dallas). J. Geophys. Res.; 76: 1764-77(1 Mar 1971).

Observations of helium 10,830-A radiation with a grille spectrometer at Socorro, New Mexico, from 1967 to 1970 are presented. The data are discussed in light of new computations of the excitation and emission profiles. The observational data show an intensity increase of a factor of 3 during this period that is closely related to a corresponding change in the solar euv radiation ($\lambda < 380$ A). A large seasonal variation is discussed that is caused in part by a 5:1 variation in the neutral helium abundance and that is augmented by seasonal variation in the conjugate photoelectron flux. In addition, a diurnal variation of the helium abundance of about 30% with a maximum in the morning is suggested. (auth)

22420 EFFECT OF COLLISIONS ON THOMSON SCATTERING IN A MAGNETIC FIELD WITH UNEQUAL ELECTRON AND ION TEMPERATURES AND ELECTRON DRIFT. Seasholtz, Richard G. (Lewis Research Center, Cleveland). J. Geophys. Res.; 76: 1793-1802(1 Mar 1971).

The two-fluid continuum theory of Thomson scattering is extended to include a uniform dc magnetic field and electron drift. The backscattered power is found to be dependent on the magnitude and direction of the magnetic field when the electron and ion temperatures are not equal. Increasing the collision frequencies reduces the influence of the magnetic field and thus causes the scattered power to be closer to the field-free case. When the electrons are drifting with respect to the ions at velocities less than critical velocity corresponding to the onset of the ion-acoustic wave instability, the spectrum of the scattered power becomes unsymmetrical and sharply peaked. Also, the total scattered power is enhanced as the drift velocity is increased. Increasing the collision frequencies increases the critical drift velocity and reduces the backscattered power. (auth)

22421 SOLAR WIND SPEED DISTRIBUTIONS: 1962–1970. Gosling, J. T. (National Center for Atmospheric Research, Boulder, Colo.); Hansen, R. T.; Bame, S. J. J. Geophys. Res.; 76: 1811-15(1 Mar 1971).

The yearly distributions of solar-wind bulk speeds during the years 1962–1970 are investigated and are found to be remarkably constant from year to year. There is no tendency for the solar-wind speed to increase with increasing solar activity. High speeds (in excess of about 550 km sec^{-1}) were more commonly observed near solar minimum than near solar maximum. For most years the average solar-wind velocity was near 400 km sec^{-1}. (auth)

22422 ORIENTATIONS OF 'ROTATIONAL' AND 'TANGENTIAL' DISCONTINUITIES IN THE SOLAR WIND. Turner, J. M. (Massachusetts Inst. of Tech., Cambridge); Siscoe, G. L. J. Geophys. Res.; 76: 1816-22(1 Mar 1971).

Previous studies of the orientations of solar wind discontinuities are extended by treating tangential and rotational discontinuities separately where quotation marks indicate that these designations are defined operationally in a way that is consistent with the expected behavior of simple tangential and rotational discontinuities. It is found that the east–west asymmetry is shared by both categories, but the north–south asymmetry appears only in the rotational discontinuities. Each group shows a well-defined preferred orientation, with the members in both groups characteristically deviating from the preferred orientation by approximately 25°. The preferred orientation of the normal to the tangential discontinuities is nearly in the solar-equatorial plane and is perpendicular to the spiral direction. (auth)

22423 MAGNETIC FIELD VARIATIONS IN THE NEAR GEOMAGNETIC TAIL ASSOCIATED WITH WEAK SUBSTORM ACTIVITY. Russell, C. T.; McPherron, R. L.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). J. Geophys. Res.; 76: 1823-9(1 Mar 1971).

Magnetic-field observations obtained with the UCLA Ogo 5 fluxgate magnetometer on an inbound pass, during which the satellite remained close to the magnetic meridian and traveled almost parallel to and approximately 2 R_E above the expected position of the neutral sheet, are used to illustrate the variations in the configuration of the tail field during weak substorm activity. Beyond 10 R_E from the Earth, changes to dipolar fields are accompanied by a reduction in field strength presumably due to plasma sheet expansion. Within approximately 10 R_E changes to a more dipolar field are accompanied by no change or by an increase in field strength. In both regions, these changes are accompanied by turbulence or noise. Occasional twisting of the field out of the usual magnetic meridian is also observed. (auth)

22424 EVIDENCE FOR DIRECT DURABLE CAPTURE OF 1- TO 8-MeV SOLAR ALPHA PARTICLES ONTO GEOMAGNETICALLY TRAPPED ORBITS. Van Allen, James A.; Randall, Bruce A. J. Geophys. Res.; 76: 1830-6(1 Mar 1971).

From satellite observations from Injun 5, an examination of the temporal variations of the intensity of geomagnetically trapped α particles was made for the 8-month period September 1968 to April 1969. The most prominent change was a stepwise increase in intensity of 1- to 8-MeV α particles in the outer zone by a factor of 40 during the period October 29 to November 1, 1968. By combining Injun 5 data for the full 8-month period with Explorer 35 observations on solar-α particles in interplanetary space and with geomagnetic storm data, it is suggested that major rapid increases in the trapped intensity of 1- to 8-MeV α particles are caused primarily by the direct capture of solar particles from the interplanetary beam, but that such capture occurs only during geomagnetic storms of appropriate characteristics. Specific characteristics are suggested. (auth)

22425 WINTER–SUMMER DIFFERENCE IN GEOMAGNETIC ACTIVITY. Wulf, Oliver Reynolds (California Inst. of Tech., Pasadena). J. Geophys. Res.; 76: 1837-40(1 Mar 1971).

From a study of K indices of geomagnetic activity for two northern and two southern hemisphere stations for the 22 years 1940–1961, it is concluded that an annual variation, summer greater than winter, can be seen in middle latitudes to a greater or lesser degree in many, if not most, individual years. (auth)

22426 GENERAL FORMULA FOR DECAY LIFETIMES OF STARFISH ELECTRONS. Stassinopoulos, E. G. (Goddard Space Flight Center, Greenbelt, Md.); Verzariu, P. J. Geophys. Res.; 76: 1841-4(1 Mar 1971).

A formula for the decay of the artificial Starfish electrons in the inner zone of the trapped radiation belt has been developed, in which the decay lifetimes are expressed as continuous functions of field strength, magnetic shell parameter, and energy. The data used in the analysis, essentially taken from a single satellite, the 1963 38C, covers the time span from Sept. 1963 to Dec. 1968. (J.C.W.)

22427 HORIZONTAL DISTRIBUTION OF HELIUM IN THE EARTH'S UPPER ATMOSPHERE. Reber, C. A.; Harpold, D. N.; Horowitz, R.; Hedin, A. E. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: 1845-8(1 Mar 1971).

The helium distribution in June 1969 was studied by using data from the mass spectrometer on Ogo 6 (perigee, 400 km; apogee, 1100 km). After normalizing for altitude effects by use of the Jacchia model atmosphere, the densities show an order of magnitude difference between the southern (winter) hemisphere and the northern (summer) hemisphere, with the maximum density occurring near −55° latitude. The exact location of the maximum varies between −40 and −70° geographic latitude and is apparently correlated with the geomagnetic dipole latitude of −53°. This correlation is consistent with the idea that the helium distribution is quite sensitive to thermospheric winds. (auth)

22428 WHISTLERS WITH HARMONIC BANDS CAUSED BY MULTIPLE STROKE LIGHTNING. Shaw, Robert R.; Gurnett, Donald A. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 76: 1851-4(1 Mar 1971).

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Unusual characteristics of the harmonic bands were observed on whistlers received by the Injun 5 vlf receivers. The center frequencies of the bands occur at equally spaced frequency intervals. This harmonic relationship shows the linear relation between the center frequencies of the bands and the band number. Because the frequency spacing of the bands is comparable to the gyrofrequency of several types of positive ions found in the ionosphere, it has been shown that the bands may be associated with harmonics of an ion gyrofrequency. Dr. R. L. Dowden noted that similar attenuation effects can be produced by destructive interference between multiple lightning strokes. Investigations have now shown that this process can explain essentially all characteristics of the harmonic bands observed on whistlers with Injun 5. Extreme care is necessary in observing the bands to determine the cause of the harmonic bands. (J.C.W.)

22429 INTERPRETATION OF HIGH-FREQUENCY DOPPLER OBSERVATIONS OF WAVES FROM NUCLEAR AND NATURAL SOURCES. Baker, Donald M. (ESSA, Boulder, Colo.); Cotten, Donald E. J. Geophys. Res.; 76: 1803-10(1 Mar 1971).

For a vertically propagating hf radio wave, the frequency shift caused by an acoustic wave propagating upward is calculated by numerical integration over the vertical path. Application is made to data taken at Boulder on October 30, 1962 and previously identified with an acoustic–gravity wave ducted horizontally from a distant atmospheric nuclear explosion. From the amplitude of the observed ionospheric disturbance, the vertical acoustic perturbation velocity amplitude is found to be 18.6 meters/sec at 190-km altitude. The corresponding displacement amplitude is found to be 266 meters. (auth)

22430 IDENTIFICATION OF MOVING MAGNETIC FIELD LINES. 2. APPLICATION TO A MOVING NONRIGID CONDUCTOR. Jones, Frank C.; Birmingham, Thomas J. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 76: 1849-50(1 Mar 1971).

It is shown that a magnetic-field line can be identified by the fixed-material point at which it intersects a moving and deforming surface S. The velocity of such field lines as determined by line tracing is the particle-drift velocity $v_E = c(E \times B/B^2)$. The result is directly proven by the method previously presented in J. Geophysical Research, Sept. 1, 1968, (NSA 22: 47961 or NSA 22: 38892). The boundary condition varies in the present calculation. The utility of this result is that the motion of low-energy charged particles is often evident from the mere topology of magnetic-field lines. (J.C.W.)

22431 CONTINUOUS RECORDING OF CRITICAL FREQUENCIES OF INDIVIDUAL IONOSPHERIC LAYERS. Kolokolov, L. E. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 610-11(1970).

Translated from Geomagn. Aeron.; 10: 767-9(1970).

An attachment to an AIS ionosonde is described for recording continuous critical frequencies of individual layers in the ionosphere. Synchronous pulses and the signals reflected from the ionosphere are applied from the ionosonde to the attachment and to a moving-film camera. It is necessary to process a large number of ionograms to study rapid, irregular phenomena in the ionosphere (traveling disturbances, magnetic–ionospheric disturbances) and variations at magnetically conjugate points. (J.C.W.)

22432 OBSERVATIONS OF GEOMAGNETIC SPP AT KALININGRAD. Namgaladze, A. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Kaliningrad Complex Ionospheric Station, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 604-5(1970).

Translated from Geomagn. Aeron.; 10: 761(1970).

An analysis of observations of regular short-period geomagnetic pulsations in 1967 is made. The diurnal pattern of the frequency of occurrence of Pc concurs with previous reports. A characteristic period for the observation site is noted. If the characteristic period is produced by toroidal oscillations of the magnetosphere, the concentration of the magnetospheric plasma at the summit of the line of force crossing the surface of the Earth at the latitude of the observation point can be determined from the periods of these pulsations. (J.C.W.)

22433 POLARIZATION OF SHORT-PERIOD Pc2–Pc4 PULSATIONS OF THE GEOMAGNETIC FIELD. Vinogradov, P. A.; Aleksandrova, I. A.; Vinogradova, V. N.; Maslovskaya, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 602-4(1970).

Translated from Geomagn. Aeron.; 10: 758-60(1970).

Some preliminary results are presented of special observations in 1967–1968 on components of SPP recorded continuously by means of a fluxmeter with a regular frequency characteristic. The dependence of SPP polarization on the time of day, the type of pulsations, and the activity of the electromagnetic field of the Earth is studied. Variations of the parameters of polarizations are shown in diagrams for Pc2, Pc3, and Pc4 pulsations. Some data relating to SPP polarization during an intense magnetic storm is examined. (J.C.W.)

22434 RELATIONSHIP BETWEEN GEOMAGNETIC PULSATIONS OF THE Pi2 TYPE AND THE PARAMETERS OF THE AURORAL ZONE. Afanas'eva, L. T.; Raspopov, O. M.; Shchepetnov, R. V.; Koshelevskii, V. K.; Nazarov, M. D. (Leningrad State Univ. Polar Geophysical Inst., Moscow. Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 600-1(1970).

Translated from Geomagn. Aeron.; 10: 756-7(1970).

A detailed analysis is performed of the relationship between the Pi2 parameters and the morphological characteristics of the auroral zone. A mechanism of Pi2 generation is proposed that explains their excitation by the arrival of a plasma blob from the tail of the magnetosphere into the auroral zone and its subsequent dumping of particles responsible for baylike geomagnetic disturbances. (J.C.W.)

22435 ELECTRON FLUX SPECTRA IN THE AURORAL REGION. Osipov, N. K.; Pivovarova, N. B. (Inst. of Cosmophysical Investigations, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 589-90(1970).

Translated from Geomagn. Aeron.; 10: 744-6(1970).

Determination of electron-flux spectra requires absolute photometric measurements whose results usually contain large systematic errors. A method is given, considering the effects of the interaction of electron fluxes with the atmosphere. Several quantities that are determined by the energy and angular spectrum of a flux, which, although they characterize the effects of the interaction of the flux with the atmosphere, are invariant for a given type of spectrum, i.e., are independent of flux density. The results of the energy and angular spectra of electron fluxes from observations at Tixie are described. Time intervals were selected when a linear relationship was reliably observed between riometric absorption, the light-flux density, and the critical E_s frequencies. (J.C.W.)

22436 INTERACTION OF PULSED RADIO WAVES IN THE IONOSPHERE. II. Vilenskii, I. M.; Israyleva, N. I. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 584-6(1970).

Translated from Geomagn. Aeron.; 10: 739-40(1970).

Expected cross modulation is estimated from different models of the ionosphere in the case of quasi-longitudinal propagation. Computations for the two models show that even when the differences between the ν and N values are insignificant in the models, marked changes in cross modulation are obtained. (J.C.W.)

22437 RELATIONSHIP BETWEEN THE SPACE–TIME VARIATIONS OF THE STRENGTH OF IONIZATION SOURCES AND OF ELECTRON DENSITY IN THE LOWER IONOSPHERE. Tulinov, V. F. Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 583-4(1970).

Translated from Geomagn. Aeron.; 10: 737-8(1970).

Investigations of the reasons for the observed variability of electron density (variability in the intensity of ionization sources, aeronomic processes, dynamic factors) in the ionospheric D region are made. Discrepancies occur in individual measurements due to unproved methods, but some patterns are established. The latitude dependence of the ionization rate and electron density in the lower ionosphere during the daytime is compared. A comparison made for the day and night data is indeterminate. The data on electron density and ionization rates show that the difference between the average ionization-rate values at middle and high latitudes is equal in order of magnitude to the difference between the n_e^2 values at these latitudes. (J.C.W.)

22438 ELECTRON DENSITY DISTRIBUTION IN THE E REGION ACCORDING TO GROUND-BASED RADIO SOUNDING DATA. Korsunova, L. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 581-2(1970).

Translated from Geomagn. Aeron.; 10: 735-6(1970).

The reflection height at 90 to 150 km in the E region was measured during July and August, 1968. Special high-resolution equipment was constructed. The variations of the electron density with solar zenith angles at constant heights reveal the same effect of morning–evening asymmetry as noted earlier

from f_0E. This effect is small at Irkutsk (testing site) during the summer, but for the same day the electron density is greater at a given height in the evening, especially at 105 km and the layer maximum is higher than in the morning. Day-to-day variations are comparable to the morning–evening effect or exceed it. (J.C.W.)

22439 SHORT-WAVE PROPAGATION ON ONE-HOP RADIO LINKS IN THE PRESENCE OF f_0F_2 GRADIENTS. Kerblay, T. S.; Kovalevskaya, E. M.; Nosova, G. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 576-7(1970)

Translated from Geomagn. Aeron.; 10: 730-1(1970).

Data on signal reception at several frequencies on the Moscow–L'vov and Moscow–Alma–Ata link in the winter of 1967–1968 were analyzed. The f_0F_2 gradients were estimated by interpolation of the data of nearby ionospheric stations. The results obtained from previous computations conclude that the presence of horizontal f_0F_2 gradients leads to an increase in the MUF on radio links and the present results confirm this. The transmission of radio waves with frequencies exceeding 15% the standard MUF in the presence of horizontal gradients is not accompanied by a drop in field strength and can be explained by an increase in the MUF due to the gradients. The transmission of radio waves with frequencies exceeding the MUF in the absence of f_0F_2 gradients is accompanied by a drop in field strength by two orders of magnitude, on the average, and can be explained by the scattering effect. (J.C.W.)

22440 $[NO^+]/[O_2^+]$ RATIO IN THE F1 REGION. Koshelev, V. V.; Shuyskaya, Z. I.; Shchepkin, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 573-5(1970).

Translated from Geomagn. Aeron.; 10: 727-9(1970).

An important characteristic of the ion structure of the ionosphere is the $[NO^+]/[O_2^+]$ concentration ratio, and values obtained from rocket and satellite measurements and theoretical investigations are given in the height interval 150 to 200 km. The C value is used in particular to determine the weighted-mean dissociative recombination coefficient, since the recombination coefficients for the ions usually differ. An attempt is made to estimate $\eta = \alpha_{O_2^+}/\alpha_{NO^+}$ and $\xi = \gamma_{O_2^+}/\gamma_{NO^+}$ from experiments. The NO and N concentrations are very poorly known. (J.C.W.)

22441 COMPUTATION OF VARIATIONS IN THE ION COMPOSITION OF THE IONOSPHERIC E REGION AT NIGHT. Mikhailov, A. V. Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 571-3(1970).

Translated from Geomagn. Aeron.; 10: 724-6(1970).

Two models are presented for the study of the nature of the variation in the nonequilibrium concentrations of NO^+ and O_2^+ ions in the E region giving an answer to the existence of the nighttime ionization source. The reason for a nighttime E layer and the character of the variation with time of electron density can be explained by the presence of an ionization source at night. One model assumes that the ionization source is cut off immediately after sunset and the NO^+ and O_2^+ ions begin to disappear through dissociative recombination. The other assumes that there is an ionization source that varies slowly with time. Then a quasi equilibrium sets in after a time interval. (J.C.W.)

22442 CYCLOTRON INSTABILITY IN THE MAGNETOSPHERE WITH ALLOWANCE FOR THE REFRACTION OF RISING WAVES. Gul'el'mi, A. V. (Inst. of Terrestrial Physics, Moscow. Borok Geophysical Observatory, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 568-70(1970).

Translated from Geomagn. Aeron.; 10: 721-4(1970).

The cyclotron instability in the distribution of energetic protons is considered with respect to the buildup of Alfvén waves with refraction in the magnetosphere. It is shown that the amplification coefficient actually has a peak during propagation at a noticeable angle to the magnetic lines of force. It is assumed that the magnetosphere is stable with respect to relatively infinite small disturbances. If backscatter with a small change in frequency is really the main nonlinear effect in the presence of refraction, only those packets of Alfvén waves are generated whose initial amplitude exceeds some critical value. This mode of triggering apparently occurs during excitation in the magnetosphere of periodic discrete signals of the Pc1 type. A transition from convective to absolute instability occurs in the magnetosphere and can probably be explained by the appearance of strong isolated pulses against the background of pulsations of increasing frequency, observed during polar substorms. (J.C.W.)

22443 INFLUENCE OF THE LOWER IONOSPHERE ON THE PROPAGATION OF HYDROMAGNETIC WAVES DIRECTED BY THE GEOMAGNETIC FIELD. Van'yan, L. L.; Gokhberg, M. B.; Abramov, L. A. (Inst. of Space Research, Moscow. Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 565-8(1970).

Translated from Geomagn. Aeron.; 10: 719-20(1970).

Directional hydromagnetic waves carry disturbances to great distances with practically no attenuation. The propagation of these waves is accompanied by the appearance of a current system in the magnetosphere; a direct and a return wave of current along the geomagnetic lines of force crossing the sources. After reaching the lower ionosphere, longitudinal currents spread out, forming the ionospheric current system. The energy field, transported by the directional wave and being responsible for the spreading of the currents over the ionosphere, generates a system of closed Hall currents. A model is considered of the circles of this system with a common center at the point of spreading having the simplest shape for an elementary, single magnetospheric current. It is shown that within a broad range the lower ionosphere does not produce any phase shifts and does not cause a delay in the propagation of disturbances from high to low latitudes. This casts doubt on the speed of propagation estimated from the known formula for a homogeneous conducting system. (J.C.W.)

22444 ONE OF THE MECHANISMS OF FORMATION OF INHOMOGENEITIES IN THE INTERPLANETARY PLASMA. Kotsarenko, N. Ya.; Koshevaya, S. V.; Yukhimuk, A. K. (Inst. of Geophysics, Kiev). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 561-4(1970).

Translated from Geomagn. Aeron.; 10: 715-17(1970).

The existence of electron-density inhomogeneities in the interplanetary plasma has been discovered by the radio-astronomic transmission method. From an analysis of the IMP-1 and IMP-3 data it was established that electron fluxes appear in interplanetary space and Mariner-4 data suggest that the increase in electron intensity is produced by pulsed emission from the solar atmosphere. Electron fluxes moving toward the Earth from the Sun are associated with the lines of force of interplanetary magnetic field, and are generally curvilinear. It is shown that the curvilinearity of an electron flux leads to instability phenomena and this may be the reason for the formation of the inhomogeneous structure of the interplanetary plasma. (J.C.W.)

22445 CONDUCTIVITY ALONG LINES OF FORCE AND SPP PARAMETERS. Barsukov, V. M.; Pudovkin, M. I. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 520-2(1970).

Translated from Geomagn. Aeron.; 10: 663-7(1970).

The effect of geomagnetic disturbances on the attenuation decrement of SPP with periods of 60 to 100 sec is examined. It is demonstrated that the longitudinal conductivity of the magnetospheric plasma can be much higher under disturbed conditions than predicted by the classic theory of rarefied plasma. The sharp increase in the attenuation decrement of SPP, observed during geomagnetic field variations, is apparently associated with plasma turbulence in the cavity of the magnetosphere, which is responsible for the generation of these pulsations. (auth)

22446 ANALYSIS OF GEOMAGNETIC Sq VARIATIONS BY THE EXPANSION OF FIELDS IN NATURAL ORTHOGONAL COMPONENTS. I. METHOD AND PROBLEMS. Vertlib, A. B.; Wagner, C.-U. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR. Zentralinstitut Physik der Erde, Potsdam, Ger.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 509-13(1970).

Translated from Geomagn. Aeron.; 10: 649-54(1970).

A brief description is given of the derivation of the method of expanding fields in natural orthogonal components. Mention is made of the possibility of interpreting this method as a particular case of a linear model of the field of values under study. Problems involved in the analysis of geomagnetic S_q variations, which the authors hope to solve by the given method, are discussed. Examples of the expansion of specific fields are given. (auth)

22447 ELECTRIC FIELD OF THE SOLAR WIND AND MAGNETIC DISTURBANCES AT THE EARTH'S SURFACE ON SEPTEMBER 26, 1966. Mikerina, N. V.; Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 504-8(1970).

Translated from Geomagn. Aeron.; 10: 643-8(1970).

The relationship between the eastern component of the electric field of the solar wind E_φ and magnetic disturbances on earth during the storm of September 26, 1966, are investigated from satellite and ground-based data. The correlation coefficient between the E_φ variations and the average hourly values of the disturbed field on Earth reached ~0.75. The shape and intensity

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of ionospheric current systems changed with the electric field, becoming most complicated and intense at the E_φ maximum. (auth)

22448 COSMOS-224 MEASUREMENTS OF DAYGLOW IN THE RANGE 1800 TO 600 A. Krasnopol'skii, V. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 500-3(1970).

Translated from Geomagn. Aeron.; 10: 637-42(1970).

Filter measurements of atmospheric luminance near the horizon showed that aerosol scattering plays an insignificant role in dayglow at heights >130 km. The diurnal pattern of dayglow is characterized by the relationship cos Z (Z is the zenith angle of the Sun). Dayglow does not have a cloud structure. The zenith intensities are given for individual components of dayglow. Airglow at heights above 130 km does not exceed 100 R in the region 1800 to 6000 A. (auth)

22449 ROLE OF THE DYNAMO MECHANISM IN PRODUCING MAGNETIC DISTURBANCES AND IONOSPHERIC INHOMOGENEITIES WITH ALLOWANCE FOR THE HEIGHT DEPENDENCE OF CHARGED-PARTICLE DENSITY IN THE IONOSPHERE. Vardanyan, Yu. S. (Moscow State Univ. Inst. of Radio Physics and Electronics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 491-4(1970).

Translated from Geomagn. Aeron.; 10: 626-9(1970).

A study is made of the electrodynamic state of the Earth's magnetosphere and ionosphere, which depends on the character of the small-scale motion of the neutral gas in the ionosphere. Allowance is made for the height dependence of charged-particle distribution. (auth)

22450 RESULTS OF MEASUREMENTS OF REGULAR RADIO WAVE ABSORPTION IN THE AURORAL-ZONE IONOSPHERE. Benediktov, E. A.; Dubkova, V. A.; Tolmacheva, A. V. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 487-90(1970).

Translated from Geomagn. Aeron.; 10: 620-5(1970).

The results of measurements by radio-astronomic methods of regular radio-wave absorption in the auroral-zone ionosphere are reported. It is found that the diurnal and seasonal dependences of integral absorption are determined by the Sun in the same degree as they are at middle latitudes. (auth)

22451 HORIZONTAL WIND SYSTEM IN THE IONOSPHERE IN PRESENCE OF VERTICAL VELOCITIES. Khantadze, A. G.; Sharikadze, D. V. (Tbilisi State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 481-6(1970).

Translated from Geomagn. Aeron.; 10: 611-19(1970).

A simplified system of equations is presented for the general circulation of the upper atmosphere with allowance for ionospheric conductivity and the presence of a permeable boundary surface. A nonstationary solution of the simplified system is found when only height z and time t are independent variables. The problem is reduced to a system of integral equations and is solved in the form of series by successive approximations. It is shown that these series converge absolutely and evenly. The solution obtained is applied to the problem of the adaptation of the nonstationary wind to a stationary wind field. The solution of the stationary problem is used to investigate the influence of vertical velocities on the speed and direction of the horizontal wind in the ionosphere. (auth)

22452 STATISTICAL PATTERNS OF N_{max} F FLUCTUATIONS AT MIDDLE LATITUDES. Vsekhsvyatskaya, I. S.; Sergeenko, N. P.; Yudovich, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 477-80(1970).

Translated from Geomagn. Aeron.; 10: 606-10(1970).

The relationships of δN_m and ΔN_m variations are obtained from experimental statistical $W(\delta f_0F_2)$ distributions for two middle-latitude stations in various phases of the solar-activity cycle. The excess model derived for describing the distributions obtained agrees well with experimental data. (auth)

22453 NIGHTTIME IONIZATION OF THE IONOSPHERIC F2 LAYER AT TEMPERATE LATITUDES. Vasin, V. A.; Grishkevich, L. V.; Pisareva, V. V. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 473-6(1970).

Translated from Geomagn. Aeron.; 10: 600-5(1970).

The influence of the ionosphere on the state of the F2 layer at the observation point is investigated on the basis of f_0F_2 data for the nighttime at Gor'ky station and the computed time of sunrise at the magnetically conjugate point. The relationship between the F2 layer parameters and the effect of the nighttime maximum N_m is analyzed. Data are given on the cross correlation between the f_0F_2 values for the network of European stations, describing the characteristics of the latitude–longitude distribution of nighttime ionization N_m. (auth)

22454 MAGNETIC SCATTER OF CHARGED PARTICLES ON CYCLOTRON-INSTABILITY WAVES OF THE RADIATION-BELT PLASMA. I. Il'in, V. D. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 453-8(1970).

Translated from Geomagn. Aeron.; 10: 575-81(1970).

The mechanism of electron loss due to resonance interaction in an inhomogeneous magnetic field with whistler-type waves is examined. Expressions for the coefficient of pitch-angle diffusion are obtained for a wave spectrum of form $dh^2/dk \propto k^{-n}$, and the relaxation times are determined. (auth)

22455 VARIATIONS IN SOLAR-WIND FLUXES AND RESULTING PULSATIONS OF THE ELECTROMAGNETIC FIELD OF THE EARTH. Gringauz, K. I.; Troitskaya, V. A.; Solomatina, E. K.; Shchepetnov, R. V. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 449-52(1970).

Translated from Geomagn. Aeron.; 10: 569-74(1970).

The preliminary results are reported of a comparison of the data on solar-wind fluxes obtained on Venus 5 and 6 between January 21 and March 21, 1969, and the data on pulsations and short-period disturbances of the electromagnetic field of the Earth recorded at Borok station. A relationship is found between increases in solar-wind fluxes and electromagnetic-field disturbances. (auth)

Low-Temperature Physics and Cryogenic Equipment

Superfluidity

22456 HEAT TRANSFER TO LIQUID HELIUM. Epstein, Michael. Berkeley, Calif.; Univ. of California (1970). 161p. University Microfilm Order No. 71-767.

Thesis.

Heat transfer to liquid helium from horizontal, face-up surfaces of normal and superconducting lead and tin, of PbS, and of Ge 7031 varnish was investigated. The nucleate regime, peak nucleate boiling flux (PNBF), film boiling regime and minimum film boiling flux (MFBF) were studied above the λ point, and the Kapitza conductance and peak flux were studied below the λ point. The PNBF for liquid hydrogen on the same surfaces was also investigated between 1 atmosphere and the triple point. (TSS) (Diss. Abstr. Int., B)

Superconductivity

Refer also to abstract 22193.

22457 ELECTRONIC SPECIFIC HEATS AND SUPERCONDUCTIVITY IN THE GROUP-V TRANSITION METALS. Ishikawa, M.; Toth, Louis E. (Univ. of Minnesota, Minneapolis). Phys. Rev., B; 3: 1856-61(15 Mar 1971).

Electronic specific heats of Nb–V alloys were measured from 1.5 to 14°K, and on the basis of these measurements superconductivity parameters were calculated. Both the McMillan and the Hopfield theories were used to try to understand the cause of the broad minimum in T_c with alloying composition. The McMillan theory indicates that the cause is a weakening of the electron-phonon interaction parameter. The Hopfield theory could not adequately predict the existence of the minimum in these alloys. (auth)

22458 LATTICE INSTABILITIES AND HIGH-TEMPERATURE SUPERCONDUCTIVITY. Phillips, J. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 26: 543-6(8 Mar 1971).

Anomalously high values of the superconductive transition temperature T_c are correlated with anomalies in bond lengths in intermetallic compounds. The bond length anomalies arise from anharmonic stabilization of harmonic lattice instabilities, and confirm this interpretation of recent neutron studies of short-wavelength vibrational anomalies. (auth)

22459 INDUCED AC LOSSES IN AN ENHANCED MEISSNER STATE. Seebold, R. J. A.; Rhodes, R. G. (Univ. of Warwick, Coventry, Eng.). J. Phys., D (London); 4: 354-5(Feb 1971).

Induced ac losses and magnetization curves measured at 4.2°K, are reported for a reversible supersaturated solid solution of Pb–11% Sn, and for the same material after the precipitation of pinning

centers. The results show lower hysteretic losses in the precipitated material for peak applied fields up to H_{fp}, as defined by slow-swept magnetization measurements, but more significantly the losses up to this field are lower than in pure lead. (auth) (UK)

22460 SUPERCONDUCTORS: APPLICATION PROSPECTS AND THE RESEARCH STATUS. Arecchi, F. T.; Ascoli, A. (CISE, Milan). Energ. Nucl. (Milan); 18: 112-23(Feb 1971). (In Italian).

New superconductor alloys with critical temperatures higher than 20°K have recently been developed. This opens new and considerable application prospects, either for obtaining magnetic fields of the order of 300 kG or for cable transmission of large quantities of electrical power. Superconductor alloys having the highest critical temperatures so far achieved require rather complex preparation techniques. However, their realization is a consequence of an explanation of superconductivity based on quantum theory, and such explanation is likely to be of help as a guide in the research of more superconductor materials, having even higher critical temperatures and preparation techniques suitable for commercial scale production. This situation commands the attention of the most skillful laboratories of the world, many of which are engaging in vast research programs on this item. New prospects and the underlying theoretical progress are reviewed. 26 references. (auth)

22461 LINEAR RESPONSE THEORY IN THE VORTEX STATE OF DIRTY TYPE-II SUPERCONDUCTORS. Takayama, Hajime; Ebisawa, Hiromichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 44: 1450-71(Dec 1970).

The vortex motion and the flux flow resistivity in dirty type-II superconductors are reexamined from the point of view of the linear response theory with respect to the applied electric field. A time-dependent Ginzburg–Landau equation for the order parameter is different from that given by Caroli and Maki. The ordering of noncommutative operators should have been improper in their work. The time-dependent order parameter shows the uniform flux flow. The resistivity is calculated in the gauge-invariant way. It has a temperature dependence different from that by Caroli and Maki. Other transport coefficients in the vortex state are also reexamined. Thermal conductivity and the thermomagnetic coefficient agree with the results by Caroli and Maki, but the Hall coefficient does not. The microwave surface resistance, calculated numerically, is in agreement with the experiment by Fischer et al. (auth)

22462 VORTEX MOTION IN SUPERCONDUCTORS CONTAINING MAGNETIC IMPURITIES. Baba, Yasumasa; Maki, Kazumi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 44: 1431-49(Dec 1970).

The recent microscopic theory of the vortex motion in type-II superconductors by Caroli and Maki is extended to that in superconductors containing magnetic impurities. Restricting the study to the dirty limit it is shown that, in a high magnetic field, a constant electric field induces a uniform motion of the order parameter in the direction perpendicular to both the electric and the magnetic fields with a velocity u = E/H, as in ordinary type-II superconductors, where E is the electric field and H is the magnetic field. The flux flow resistivity as well as the thermomagnetic effects are calculated in the high-field region. (auth)

22463 COMMENTS ON SUPERCONDUCTORS WITH MAGNETIC IMPURITIES. Sakurai, Akio (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 44: 1472-76(Dec 1970).

A low-lying excited state in a superconductor with a classical magnetic spin is studied in connection with the ground-state problem. The occurrence of a level crossing between them is pointed out. (auth)

22464 JOSEPHSON CURRENTS THROUGH JUNCTIONS WITH NORMAL METAL BARRIERS. Ishii, Chikara (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 44: 1525-47(Dec 1970).

The SNS-contact junction in the thick-barrier limit ($\xi_0/2d \ll 1$) at low temperature ($T \ll T_c$) is simulated by a step-wise one-dimensional off-diagonal potential, with different macroscopic phases for each of the superconductors, comprising the junction. The one-particle Green's functions are constructed by taking into account the boundary scattering effects at the superconductor/normal metal interfaces completely, and are used to calculate the zero-voltage barrier supercurrent. The supercurrent is shown to be a sectionally linear periodic function of relative phase between the superconductors, the amplitude of which is inversely proportional to the thickness (2d) of the normal barrier. The associated phase coupling energy is conjectured by making use of the close analogy of the diagrammatic structures of the barrier supercurrents of the SNS junction to that of the SIS junction. (auth)

22465 ENERGY LOSSES IN SUPERCONDUCTORS AND FERROMAGNETICS IN THE HIGH FREQUENCY BAND. Fedotov, L. N. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met.; No. 71, 180-8 (1969). (In Russian).

Methods are considered for measuring small and large losses in technical equipment using very high frequencies, e.g., delay lines and resonators. Data are given for the measurement of losses in superconducting Nb delay lines, for the quality of resonators, and the coefficient of loss decrease for the Nb–Ti–Zr alloy 65BT, for Pb and Nb. The frequency dependence of loss in Fe–Al and Fe–Mn systems is also reported. (Referativnyi Zh.)

Equipment and Devices

Refer also to abstracts 21477 and 21483.

22466 (UCSD-34-P-143-37) THERMAL CONTACT: NARRATIVE OF SOME EXPERIMENTS IN LOW TEMPERATURE PHYSICS. Wheatley, John C. (California Uni.v., La Jolla, San Diego. Dept. of Physics). [nd]. Contract AT(04-3)-34. 24p. Dep. NTIS.

Plasma and Thermonuclear Physics

22467 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS, VOLUME 4, NO. 12, 1970. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 63p.

This listing includes 294 articles on various aspects of controlled thermonuclear research. (M.O.W.)

22468 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS, VOLUME 5, NO. 1, 1971. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 51p.

This listing includes 277 articles on various aspects of controlled thermonuclear research. (M.O.W.)

Confinement and Heating

Refer also to abstracts 22534 and 22535.

22469 (IPP-1/111) LINEAR EXPERIMENT WITH l = 1 ON THE HIGH-β-STELLERATOR ON ISAR I. Kaufmann, M.; Fuenfer, E.; Junker, J.; Neuhauser, J. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Aug 1970. 28p. (In German). Dep. NTIS (U. S. Sales Only).

In preparation for a toroidal high-β stellarator, a linear experiment with helical l = 1 symmetry was made on the ISAR-I theta pinch. The fast theta-pinch-like shock heating in the presence of a helical field and the buildup of a plasma column were investigated. It could be seen that the plasma formed a screw near the axis of the vacuum magnetic field. Neither rapidly growing instabilities nor enhanced diffusion was found. (auth)

22470 WAVE-MECHANICAL MODEL FOR THE NONADIABATIC LOSS OF PARTICLES FROM MAGNETIC-MIRROR TRAPS. Varma, Ram K. (Univ. of Texas, Austin). Phys. Rev. Lett.; 26: 417-20(22 Feb 1971).

A model is presented which describes the nonadiabatic loss of particles from magnetic mirror traps through a Schroedinger-like equation where the role of $\hbar$ is played by the "first action invariant." The process is thus found to be analogous to the "tunneling effect" in quantum mechanics. The predictions of the model for the lifetimes compare very well with the experimental results. (auth)

22471 NEW EXPERIMENTAL RESULTS ON THE BEHAVIOUR OF THE POSITIVE COLUMN IN MAGNETIC FIELD. Toader, E. I. An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.; 17: 27-37 (1968). (In Rumanian).

The behavior of the positive column of a helium discharge in a longitudinal magnetic field was studied. The magnetic field variations of the axial electron content and axial-ion and wall-ion current densities were found. Also, the constriction of a plasma column in a magnetic field is considered. (auth) (Rom. Sci. Abstr.)

22472 LINEAR RESISTIVE-LOADING STUDIES NEAR THE LOWER HYBRID RESONANCE IN DEUTERIUM AND HYDROGEN

PLASMAS. Rust, Ray Dean. Austin, Tex.; Univ. of Texas (1970). 148p. University Microfilms Order No. 71-184.

Thesis.

A new experimental device, the 2-B machine, was designed and constructed to investigate further the lower hybrid resistive loading. This machine eliminated the questionable techniques of previous experiments. In the 2-B machine the plasma was generated by inductive coupling to a 40-kW rf oscillator. The testing region of the 2-B machine was separated physically and electrically from the generation regions. This physical arrangement allowed a separate 40-watt transmitter to be used as the testing apparatus for a linear resistive-loading experiment. Resistive-loading experiments were run for various initial gas pressures and external magnetic field values in hydrogen and deuterium. The resistive-loading curves resulting from these experiments were compared with three theoretical models. This comparison showed agreement between theory and experiment only when the finite geometry of the plasma system was included in the theoretical description of the system. The geometry of the plasma system produced "geometric resonances" in addition to the lower hybrid resonance in the resistive-loading curves. The agreement in structure as well as absolute values of the resistive-loading curves was more favorable for deuterium than for hydrogen. (Diss. Abstr. Int., B)

22473 TURBULENT-HEATING MECHANISMS IN STRONG ELECTRIC FIELD. Warnke, Dale Franklin. Columbus, Ohio; Ohio State Univ. (1970). 99p. University Microfilms Order No. 70-26,385.

Thesis.

The roles of high-frequency drift and beam–plasma instabilities in turbulent heating are studied in a linear discharge. A maximum discharge current of ~70 kA is attained in ~1.5 μsec with a 1-μF, 40-kV capacitor. The quasi-stationary axial magnetic field is varied from 0 to 10 kG and the ambient He and D pressure from 0.1 to 100 μ. Over $\frac{1}{3}$ of the capacitor energy is transferred to plasma electron thermal energy before the current maximum is reached. The resistance is essentially independent of the ambient pressure and the axial magnetic field. When the pressure is below 1 μ, all plasma electrons are heated to kT_e of ~40 keV. The initial discharge potential is 40 kV. At higher pressures, the fraction of hot electrons decreases rapidly, but kT_e for the hot component falls only slightly. The ions remain relatively cool. The microwave radiations are consistent with the characteristic frequency of the high-frequency drift instability. The high drift velocities required to heat plasma electrons to kT_e = 40 keV may be explained by multiple annular current sheets, observed to be collapsing rapidly through the plasma toward the center of the discharge. The resistance partially agrees with an anomalous resistance model based on the high-frequency drift instability with the current in an annulus determined by the skin depth. (Diss. Abstr. Int., B)

22474 EFFECT OF ELECTRIC FIELD ON PARTICLE MOTION IN A STELLARATOR. Komin, A. V.; Lobanov, K. M.; Ustyuzhaninov, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1043-6(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1346-50(Jul 1970).

A study is made of the motion of charged particles in a stellarator magnetic field with a superimposed electric field having equipotential surfaces that coincide with the magnetic surfaces of the stellarator. Boundaries are determined for the region of particle loss from the trap in both coordinate and velocity space for a parabolic distribution of the potential along a radius. (auth)

22475 EFFECT OF THE DIVERTOR MAGNETIC SURFACE ON TOROIDAL DRIFT OF A PLASMA. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1222-4(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1573-5(Jul 1970).

The divertor of the Sirius stellarator is connected by one of its end faces to a semitorus whose major radius is 40 cm and tube inner diameter 7 cm. The passage of plasma along the toroidal segment in the divertor configuration was compared with that in the solenoidal configuration. (M.O.W.)

22476 THERMAL INSULATION, CONTAINMENT, AND OHMIC HEATING IN URAGAN, A HIGH-SHEAR STELLARATOR. Vishnevetskii, V. N.; Volkov, E. D.; Dikii, A. G.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1257-8(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1615-17(Aug 1970).

The results of an investigation of thermal insulation and plasma confinement in the l = 3, high-shear racetrack stellarator Uragan (Hurricane) are presented. The dependence of the energy confinement time and the plasma decay time on shear and the confinement field are studied. The experimental data are in qualitative agreement with the theory of drift instabilities in an inhomogeneous plasma. (auth)

22477 RADIAL DIFFUSION IN A POSITIVE COLUMN IN A LONGITUDINAL MAGNETIC FIELD. Vagner, S. D.; Kagan, Yu. M.; Krylov, N. A. (Karelian Pedagogical Inst., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1159-63(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1501-6(Jul 1970).

Measurements were made of the ambipolar diffusion coefficients in helium and neon positive columns. The measurements were performed in discharge tubes 1 m long with the cathode inside the solenoid and 1.5 m long with the cathode outside the solenoid. The current density at the wall, electron density, and electron temperature on the axis were measured. (M.O.W.)

22478 HEATING OF A PINCH. Mewe, R. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Z. Naturforsch.; 25a: 1803-7(Dec 1970).

The compression temperature of a theta pinch is calculated as a function of the circuit parameters and the final β-value of the plasma. One of the results is that the temperature, $\hat{T}$, at the peak magnetic field, $\hat{B}$, scales of $(\hat{B}\dot{\hat{B}})^{\frac{2}{3}}$, where $\dot{\hat{B}}$ is the initial rate of rise of the magnetic field. A possibility of combining two capacitor banks to increase the implosion heating rate is discussed. (auth)

22479 HEATING OF LASER-PRODUCED PLASMAS GENERATED AT PLANE SOLID TARGETS. I. THEORY. Puell, H. (Technische Univ., Munich). Z. Naturforsch.; 25a: 1807-15(Dec 1970).

A hydrodynamic model for the heating of a plasma generated by the interaction of an intense giant laser pulse with a plane, solid target is developed. It is shown that, in the case of nanosecond light pulses and a finite focal spot diameter, the plasma production may be considered as a steady-state problem. Expressions for the electron temperature, the expansion energy of the ions, and the total particle number in the plasma as a function of the incoming light intensity are derived. An estimate of the ion temperature is discussed. (auth)

22480 TRAPPED PARTICLES IN TOROIDAL MAGNETIC SYSTEMS. Kadomtsev, B. B.; Pogutse, O. P. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 11: 67-92(Jan 1971).

The review is devoted to the discussion of the role of trapped particles for equilibrium, diffusion, and stability of plasmas in toroidal magnetic devices. The motion of single particles in a toroidal magnetic field, the neoclassical transport processes due to the trapping of particles, and trapped-particle instabilities in toroidal geometry are discussed. The relations between the neoclassical theory of diffusion, the turbulent transport processes due to the instabilities, and the existing experimental Tokamak data are discussed. (auth)

22481 COMMENTS ON THE ION HEATING AND ELECTRIC CONDUCTIVITY OF A PLASMA WITH A DEVELOPED ION-ACOUSTIC TURBULENCE. Sizonenko, V. L.; Stepanov, K. N. (Physical-Technical Inst., Kharkov). Nucl. Fusion; 11: 93-4 (Jan 1971).

It is shown that the main mechanism of the interaction between cold ions and turbulent ion acoustic oscillations in an unmagnetized ($\omega_{pe} \gg \omega_{He}$) plasma, leading to ion heating and to the appearance of anomalous plasma resistance, may be ion scattering in turbulent pulsations due to the finite character of correlation time of the Fourier amplitudes $\phi_{\vec{k}}(t)$ of the electric potential of the oscillations $\phi(\vec{r},t)$. (M.O.W.)

Diagnostics

Refer also to abstract 22507.

22482 (ORO-3393-5) APPLICATIONS OF LIGHT SCATTERING TO PLASMA DIAGNOSTICS. Progress Report. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Nov 1970. Contract AT(40-1)-3393. 71p. Dep. NTIS.

Research results are presented on the following topics: (1) collisionless coupling between plasmas and magnetic fields in a high-voltage theta pinch, (2) "experimental rate coefficients for collisional excitation of lithium-like ions," (3) measurement of excitation rate coefficients for beryllium-like ions, and (4) light scattering from high-density plasmas. (auth)

22483 INQUIRY INTO THE NATURE OF THE CHARGED-PARTICLE PRECURSOR IN FRONT OF STRONG SHOCK WAVES

IN ARGON AND XENON. Dove, William Graham Jr. Rochester, N. Y.; Univ. of Rochester (1970). 281p. University Microfilms Order No. 71-1379.

Thesis.

The history of strong-shock-wave research in the rare gases is reviewed to provide a reference point. Possible causes for the previously observed precursor phenomenon are briefly investigated theoretically; none of the causes considered agreed with previous experimental results. The possible plasma diagnostics for the problem are considered; the choice was made to rely on X-band microwave interferometry and spherical Langmuir probes biased to collect ions. It was decided to interpret the interferometer phase shift using the simple adiabatic relation. It was also decided that the most pertinent theory for the Langmuir probe data was that of Su and Lam (1963). The interferometer performance was such that number densities $\gtrsim 10^8$ cm^{-3} could be detected over the 2" test section. Plasma number densities up to $\approx 10^9$ cm^{-3} were measured in argon, at pressures ranging from 0.40 to 6.25 torr, with corresponding shock-wave Mach numbers of 13.9 to 9.88; e-folding lengths were typically 30 cm. A limited number of xenon data runs gave number densities $\approx 10^{10}$ cm^{-3}, with e-folding distances ≈50 cm. The experimentally determined electron temperature in the argon data was qualitatively found to be ≈1 eV. The simultaneous solution of the microwave and probe data was not successful; the interpreted probe currents appear to be too large by a factor of 10 to 100. Numerous small experiments were run in an effort to learn more about the problem. It is concluded that optically thin photoionization is the dominant cause of the precursor plasma under the existing experimental conditions; however, no identification of the ion species involved was possible. It appears that shock-tube wall reflectivity plays an important role in determining the details of the precursor formulation. (Diss. Abstr. Int., B)

22484 MEASUREMENTS OF ELECTRICAL PROPERTIES OF FLAMES. Silla, Harry. Hoboken, N. J.; Stevens Inst. of Tech. (1970). 227p. University Microfilms Order No. 71-1186.

Thesis.

The use of electrostatic probes in the continuum region and in a flame plasma was investigated. The investigation was restricted to a weakly ionized plasma where the ion sheath is thick. Electron temperatures were measured in carbon monoxide–oxygen flames seeded with ethane and sodium chloride at 49 mm Hg. It was found that high electron temperatures could always be attributed to either experimental errors or to misinterpretation of current–voltage characteristics. It was found that a single probe could measure electron temperatures just as reliably as double probes. Single probes can measure the same quantities as double probes, plus they have the possibility of making other measurements. Some of the probe theories for very negative probes, which are commonly used in flames, were critically examined and compared. (TSS) (Diss. Abstr. Int., B)

22485 DETERMINING THE TEMPERATURES OF ATOMIC AND IONIC EMISSION SPECTRA. Ionescu-Bujor, T. An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.; 17: 39-43(1968). (In Rumanian).

The ratios of spectral line intensities were used to determine the temperature of a quasi-isothermal hot plasma using Al–Al and Al–C electrodes and Al 3082.2- and 3074.4-Å spectral lines. The resulting data are indicative of a local thermodynamic equilibrium in the spark central area. (auth) (Rom. Sci. Abstr.)

22486 MEASUREMENT OF TEMPERATURE IN A HIGH-FREQUENCY INDUCTION PLASMA. Kasai, Takeshi; Muto, Kihachi; Kiwaki, Hisatomo. Denki Shikensho Iho; 34: 760-6 (1970). (In Japanese).

The radial temperature distribution of an argon plasma maintained inductively at an atmospheric pressure is measured by the use of a relative line intensity method, and transition probabilities of an argon atom are investigated by applying a Boltzmann plot method. This experiment was performed on conditions that the oscillator frequency of the source is 5.8 MHz, plate input power is 8 kW, and gas flow rate is about 22 l/min. The values of temperature calculated for the intensity ratio of line-to-line, line-to-continuum and continuum-to-continuum are compared with each other. The temperature distribution is of an off-axis peak with about 12000°K on the plasma axis. (auth) (Japan)

22487 ROTATING VANE ELECTROMETER OF HIGH SENSITIVITY. Hammond, D. P. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., E (London); 4: 97-8(Feb 1971).

An electrometer was developed that is intended primarily for measurement of electric fields associated with magnetically confined laboratory plasmas. The main features of the design are that sensitivity and time resolution were significantly increased beyond the limits existing in present instruments of this type so that fields of the order of a few volts per centimeter can be detected, provided that fluctuations in the field have a time constant greater than a few milliseconds. (auth) (UK)

22488 METHOD OF MEASUREMENT OF NONEQUILIBRIUM ELECTRIC FIELDS IN TURBULENT PLASMA BASED ON STARK BROADENING OF HYDROGEN SPECTRAL LINES. Zagorodnikov, S. P.; Smolkin, G. E.; Striganova, E. A.; Sholin, G. V. (Inst. of Nuclear Energy, Moscow). Dokl. Akad. Nauk SSSR; 195: 1065-8(11 Dec 1970). (In Russian).

Studies of the stark broadening of hydrogen spectral lines using high-speed electron-optical spectrochronography made it possible to determine the presence and nature of nonequilibrium electric fields in plasma, to measure the level of turbulence, and to determine the dynamics of development of the nonequilibrium state in various phases of the fast process. (R.V.J.)

22489 LENGTH AND COLLISIONAL EFFECTS OF A CYLINDRICAL LANGMUIR PROBE ALIGNED WITH PLASMA FLOW. Chang, Cheng-fang. Evanston, Ill.; Northwestern Univ. (1970). 180p. University Microfilms Order No. 71-1815.

Thesis.

Collisionless plasma flow over a cylindrical probe aligned with the flow is analyzed under the assumption that the ion thermal speed is negligible compared to the flow speed. At the thin sheath limit the result of the quasi-neutral solution following the formulation of Lam and Greenblat shows that the potential and therefore the plasma density vary along the longitudinal axis of the probe and reach a limiting value asymptotically downstream. The sheath solution is obtained from the conservation relationship using adjusted quasi-neutral solution at the sheath edge and assuming the sheath structure to be that of the Childs–Langmuir type. The resulted variation of the ion collection along longitudinal axis is found to be due to the combined feeding of ions both through the blunt end of the sheath and the sheath edge which grows downstream. Furthermore, the asymptotic ion collection further downstream agrees with the result of the quiescent solution and the ion collection tends to increase as the ratio of the probe radius to Debye length decreases. Experimental data confirm above findings. Experiments with a group of probes across the disc shock demonstrated that ion–ion self-interactions, though incapable of changing the ion overall momentum, certainly are capable of changing the individual ion orbits, thus populating the trapped orbits always available around a cylindrical probe and causing the ion current collection to decrease. Spectroscopic measurements performed inside the barrel shock suggested, for the probe measurement, the feasibility of applying the ion–neutral collision theory to account for the loss due to interactions with other particles. (Diss. Abstr. Int., B)

22490 OPEN BARREL-SHAPED CAVITIES FOR PLASMA DIAGNOSTICS. Moskalev, I. N.; Petrov, V. P.; Stefanovskii, A. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1316-22(Feb 1971). Translated from Zh. Tekh. Fiz.; 40: 1692-1700(Aug 1970).

Simple waveguide concepts are used to calculate the characteristic frequencies of open barrel-shaped cavities with reasonable accuracy. The results of a more rigorous theory based on the solution of the wave equations, taking account of the boundary conditions, are also given. The theoretical results are compared with the experimentally measured field distributions of an 8-mm cavity. Plasma density measurements carried out with this cavity are compared with probe measurements. (auth)

22491 EMISSION PROBES FOR MEASUREMENT OF PLASMA PARAMETERS IN A STRONG MAGNETIC FIELD. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1259-63(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1618-24(Aug 1970).

A method for measuring the plasma potential in a strong magnetic field (1.5 to 10 kOe) is described. The measurements are performed in a stellarator with the use of emission probes. A method for estimating the electron temperatures in a magnetoplasma is suggested. (auth)

22492 PLASMA DIAGNOSTICS IN THE TM-3 TOKAMAK WITH A FAST HYDROGEN ATOMIC BEAM. Kislyakov, A. I.; Petrov, M. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1252-6(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1609-14(Aug 1970).

Plasma diagnostics in the TM-3 Tokamak were carried out with a fast hydrogen atomic beam (4 to 14 keV). It is shown that under certain conditions the path-averaged density of protons in the plasma can be determined from the beam attenuation. Under

other conditions it is possible to determine the upper limit of the proton density. The proton density is compared with the electron density as measured by a microwave interferometer. The beam attenuation is used to obtain data on multiply charged impurity ions in TM-3. (auth)

22493 SPACE POTENTIAL IN A MAGNETIZED PLASMA. Golovanivskii, K. S. (Patrice Lumumba Univ., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1146-8(Jan 1971). Translated from Zh. Tekh. Fiz.; 40: 1486-9(Jul 1970).

The amplitude of plasma noise is measured as a function of the potential of cylindrical probe. It was found that for probe potentials positive with respect to the plasma the amplitude of the noise is much greater than in the case of negative potentials of the probe. The method is used to measure the transverse distribution of potential in a beam of hydrogen plasma with a density of ~10^{12} cm^{-3} in a magnetic field of ~2000 G. (auth)

22494 USE OF A MULTIGRID PROBE IN A PLASMA WITH DIRECTED FLOW. Dobrokhotov, E. I.; Moskalev, I. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1063-7(Jan 1971). Translated from Zh. Tekh. Fiz.; 40: 1371-7(Jul 1970).

The use of multigrid probes is discussed in relation to the measurement of macroscopic parameters. The collector current is calculated for a probe oriented along the drift direction and in the opposite direction for two cases: (1) input aperture thickness much smaller than the entrance aperture and (2) much greater. A method is presented for processing experimental data by means of calculated curves. (auth)

22495 PLASMA DIAGNOSTICS WITH AN OPEN CYLINDRICAL CUTOFF RESONATOR. Burtovoi, D. P.; Mironenko, V. L.; Tereshchenko, A. I. (Kharkov Inst. of Radio Electronics). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1068-70(Jan 1971). Translated from Zh. Tekh. Fiz.; 40: 1378-81(Jul 1970).

The use of an open cylindrical cutoff resonator to study a plasma is discussed. Equations are presented for calculating the plasma density and the effective electron–heavy particle collision frequency from the measured phase shifts and broadening of the resonator response. Experimental results are presented for a neon discharge and a resonator excited in the H_{011} mode at 10,422 MHz. The open resonator is recommended for use with radially uniform plasmas. (auth)

22496 MICROWAVE RE-ENTRY PLASMA DIAGNOSTICS. Rybak, James Patrick. Fort Collins, Colo.; Colorado State Univ. (1970). 241p. University Microfilms Order No. 71-2428. Thesis.

An analysis of surface-mounted aperture antenna admittance was performed to determine the conditions under which admittance measurements can be used for reentry plasma diagnostics. Aperture admittance values are calculated for typical reentry plasma conditions using a formula derived in the current study from linearized, hydrodynamic, compressible plasma theory principles. The primary contribution of the present work is the determination that the admittance of a thin, microwave aperture antenna, located on the surface of a reentry vehicle, can be used to obtain the values of the electron density, electron collision frequency, ion sheath thickness, and electron temperature of the reentry plasma. It is further demonstrated, by using admittance measurements made during a reentry test flight as reported by Mayhan et al., (1968 IEEE Trans. Antennas and Propagation, AP-16, 573), that open-ended-wave-guide antenna admittances can be used to determine the plasma electron density, electron collision frequency and plasma stand-off distance when the reentry plasma is separated, due to aerodynamic boundary layer effects, from the surface of the reentry vehicle. The reentry plasma values determined from waveguide antenna admittance measurements are shown to be consistent with those predicted by pre-flight, air-chemistry analysis. Studies concerning the use of microwave antennas to diagnose the properties of highly inhomogeneous reentry plasma sheaths and an analysis of aperture antenna admittance based on kinetic plasma theory principles are suggested as topics for future work. (TSS) (Diss. Abstr. Int., B)

22497 TRANSIENT ION SHEATH EFFECTS ON PROBE ADMITTANCE. Bunting, W. D. Jr.; Heikkila, W. J. (Univ. of Texas, Dallas). J. Appl. Phys.; 42: 1136-44(1 Mar 1971).

The ion sheath around a spherical metallic probe in a laboratory plasma was investigated. The transients were initiated by step-function changes in the probe potential; only negative potentials were used in order to minimize the disturbance to the ambient plasma. The ion sheath was detected through its effect on the complex admittance of the probe at two frequencies, 5 and 15 MHz. The plasma frequency was varied over the range 5 to 32 MHz. As expected, the admittance transients were quite rapid (<50 μsec except close to the plasma frequency) following application of a large negative probe bias; under this condition the electrons are quickly repelled to form a new thicker ion sheath about the probe, and further slow changes are too small to be measured. The return to a smaller negative bias also has an initial rapid variation due to the return of the electrons, but this is followed by a much slower part due to the ambipolar diffusion back to the steady-state thin-sheath configuration. Undershoots and overshoots were observed near the plasma frequency. An approximate theory for the transient sheath properties is described and numerical results of the theory for a typical plasma condition are presented. A few discrepancies are noted, but in general there is agreement between the numerical results and the experiment. (auth)

Kinetics (General)

22498 RECOMBINATION IN A DENSE ARGON PLASMA. Shamin, A.; Wooding, E. R. (Royal Holloway Coll., Englefield Green, Eng.). Phys. Lett.; 34A: 219-20(8 Mar 1971).

A recombination coefficient in an argon plasma at atmospheric pressure was deduced from measurements of the temperature after the application of a pulsed magnetic field to an rf plasma. (auth)

22499 EFFECT OF ELECTRON COLLISIONS ON INSTABILITIES IN BEAM–PLASMA SYSTEMS. Baranchuk, N. S.; Kotsarenko, N. Ya.; Levitskii, S. M. (Kiev State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1051-7(Jan 1971). Translated from Zh. Tekh. Fiz.; 40: 1355-62(Jul 1970).

The influence of electron collisions on instabilities in beam–plasma systems was investigated theoretically and experimentally. It is shown that such collisions can convert an absolute instability to a convective instability. The criteria for conversion were determined and it was established experimentally that a smooth change in operating conditions changes the system from an oscillator (absolute instability) to an amplifier (convective instability). (auth)

22500 ION EMISSION FROM A BEAM–PLASMA DISCHARGE. Demirkhanov, R. A.; Kursanov, Yu. V.; Skripal, L. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1047-50(Jan 1971). Translated from Zh. Tekh. Fiz.; 40: 1351-4(Jul 1970).

The possibility of using a beam–plasma discharge as an ion emitter in ion source is noted. The high temperature of the electrons in such a discharge makes it possible to increase the ion current density by virtue of compensation of the ion space charge by fast electrons. The results of the experimental investigation of hydrogen-ion emission along a magnetic field are given. The dependence of the current and energy of the emitted ions on the gas pressure in the discharge chamber, the current of injected electrons, and the magnitude and shape of the magnetic field are determined. The ion current is 3 A for injection of an electron beam with an energy of 1 keV and current of 0.6 A. (auth)

22501 HIGH-CURRENT VACUUM DISCHARGE IN AN END-TYPE PULSED PLASMA ACCELERATOR. Derevshchikov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1196-9(Jan 1971). Translated from Zh. Tekh. Fiz.; 40: 1546-9(Jul 1970).

The effect of pinching on the plasma emission spectrum and on the discharge structure in end-type pulsed plasma accelerators with eroding electrodes is considered. The continuous plasma emission spectrum and a qualitative example of the change of spectral composition of the emission in time are shown. A comparison is made with previously published data. (auth)

22502 FLUX INHOMOGENEITIES IN A PULSED ELECTROMAGNETIC ACCELERATOR. Rushailo, A. M. Zh. Prikl. Mekh. Tekh. Fiz.; No. 4, 143-9(Jul-Aug 1970). (In Russian).

Earlier studies with pulsed electromagnetic accelerators revealed a layer-like structure of the accelerated ionized gas flux; the system possesses an oscillation frequency of several megahertz. The origination of such inhomogeneities in the flux of a coaxial erosion accelerator was studied by means of a slit technique. The data indicated that the inhomogeneities are due to the effect of the electromagnetic terminals. It was found that the plane, axially symmetric inhomogeneities appear in regions, in which the flux is slowed down behind the terminal shock wave and near the surface of the electrodes at the end of the accelerator channel. Desorption and evaporation phenomena at the electrode surface contribute to the appearance of the inhomogeneities. Experiments were carried out to create deep and stable inhomogeneities by slowing down the flux in regions of intensive evaporation of the insulator. These experiments on artificially induced inhomogeneities confirmed the above assumptions. (TTT)

22503 EFFECT OF ANISOTROPY OF CONDUCTIVITY ON DISTRIBUTION OF CURRENT AND THERMAL FLUX IN HIGH-CURRENT PLASMA ACCELERATORS. Dorodnov, A. M.; Ivashkin, A. B.; Kozlov, N. P.; Ostretsov, I. N.; Safonov, I. B. (Moscow School of Tech.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 56-61(1970). (In Russian).

Distribution curves for the thermal flux and current density along the external electrode in a high-current plasma accelerator were obtained at various electrode polarities. A shift of maximum thermal flux and current density by shear of the external electrode was observed in the case of the external anode. The observed effect was produced by anisotropic conductivity in the accelerator cavity, which was strongly displayed in the near-electrode $\omega\tau$ layer. (tr-auth)

22504 STRUCTURE AND ROLE OF RADIAL STRIATIONS IN A COAXIAL PLASMA ACCELERATOR. Grunberger, Lawrence Walter. Hoboken, N. J.; Stevens Inst. of Tech. (1970). 270p. University Microfilms Order No. 71-1169.

Thesis.

The current sheath in a coaxial plasma accelerator is examined, with emphasis upon the radial and aximuthal filaments that are embedded in it. Magnetic-probe measurements and image-converter photographs reveal that, under certain conditions, and within the limits of resolution of the apparatus, the leading edges of the current and luminous structures coincide. Probe measurements incidentally reveal turbulent magnetic fields behind the current sheet, and parallel-to-B_0 vortices of the type discussed by Bostick, Farber, and others. Elementary measurements of neutrons and x rays from the plasma focus provide inconclusive evidence for the Bostick theory of vortex annihilation. The observation of hard (>200 keV) x rays is not satisfactorily explained by currently-accepted theories. A theoretical treatment due principally to Nardi shows that the corrugations in the current sheet imply the existence of regions of vorticity that are spatially correlated with the filaments. (Diss. Abstr. Int., B)

22505 SOME NEW PROPAGATION PHENOMENA OF THE ELECTROMAGNETIC FIELD AND THEIR INTERPRETATION IN THE HIGH-FREQUENCY TORCH AT SUBATMOSPHERIC PRESSURES. Bohatiel, T. An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.; 18: 51-72(1969).

A whole range of new phenomena observed in a high-frequency torch is analyzed. The occurrence of phenomena such as simple or double stratifications or plasmoids was attributed to the propagation of the electromagnetic field in the high-frequency torch. Ionescu's formula for the propagation velocity of the electromagnetic field in ionized gases was used to find the discharge electron density. It was concluded that the electrical mechanism is prevalent in ionization, since thermal ionization could not account for the phenomena observed. They are accurately explained by the propagation of the electromagnetic field in all the gases investigated. (auth) (Rom. Sci. Abstr.)

22506 EXPERIMENTAL RATE COEFFICIENTS FOR COLLISIONAL EXCITATION OF LITHIUM-LIKE IONS. Kunze, H.-J.; Johnston III, W. D. (Univ. of Maryland, College Park). Phys. Rev., A; 3: 1384-93(Apr 1971).

Collisional excitation rates in N V, O VI, and Ne VIII were derived from absolute line intensities emitted by these ions in a well-diagnosed plasma. The plasma was produced in a θ-pinch device, and several plasma conditions were investigated. The electron density and temperature were obtained as a function of radius and time from the spectrum of scattered laser light. The experimental results are compared with Bely's calculations using the Coulomb–Born approximation. Although the maximum error of the individual rate coefficients is a factor of 2, the standard deviation of the experimental values from the theoretical ones is less than 30% for excitation to the n = 2 and n = 3 levels and less than 40% for excitation to the 4s level. The rates to the 4p and 4d levels are on the average ~60% of the theoretical ones. (auth)

Kinetics (Experimental)

22507 STUDY ON THE VELOCITY OF PLASMOIDS FROM A COAXIAL PLASMA GUN. Gueltekin, Ergun (Istanbul Univ.). Istanbul Univ. Fen Fak. Mecm., Seri C.; 33: 65-75(Jan-Oct 1968).

The velocity of plasmoids obtained in a coaxial plasma gun with a radial magnetic field was measured by means of two coils placed externally on the drift tube and connected to a double-beam oscilloscope. A velocity of $\sim 0.55 \times 10^5$ cm/sec was found, which was almost independent of the pressure between 200 and 1100 microns. The energy of the capacitor bank was 700 joules. (auth)

22508 NONLINEAR LIMITATION OF DOUBLE-STREAM INSTABILITY. Fedorchenko, V. D.; Rutkevich, B. N.; Muratov, V. I. (Physical-Technical Inst., Kharkov). Nucl. Fusion; 11: 43-50 (Jan 1971).

The instability during a beam–plasma discharge was studied under conditions where the density of the beam is close to that of the plasma. It is experimentally demonstrated that the rise of the space-charge waves at a certain distance from the input antenna is followed by damping. A possible mechanism is discussed by which the double-stream instability is stabilized. (auth)

22509 EXPERIMENTAL INVESTIGATION OF THE MICROWAVE RADIATION EMITTED BY A HIGH-CURRENT RELATIVISTIC ELECTRON BEAM. Nation, J. A.; Gardner, W. L. (Cornell Univ., Ithaca, N. Y.). Nucl. Fusion; 11: 5-14(Jan 1971).

The development of a high-frequency instability in a relativistic electron beam, propagating through a drift space, was studied from measurements of the microwave emission from the beam. The results show that a part of the radiation is emitted from the region close to the beam front and that the intensity of this emission grows in time as it is convected along with the beam. The growth rate is of the order of 10^8 s^{-1} and depends on the macroscopic flow parameters. Experiments in different gases show that the growth rates are approximately proportional to the ionization probability of the gas. Precursor radiation is also monitored at power levels comparable to those found at the beam front. Possible explanations of the radiation are proffered and the physical importance of the emission (~100 kW/m length of drift tube) on beam neutralization and structure are indicated. (auth)

22510 CONTROL UNIT FOR EXPERIMENTS WITH COLLIDING CHARGED-PARTICLE BEAMS. Molyneux, L.; Dolder, K. T.; Peart, B. (Univ. of Newcastle upon Tyne, Eng.). J. Phys., E (London); 4: 149-51(Feb 1971).

A control unit, constructed from integrated circuit logic units, that will generate waveforms necessary to control experiments with colliding charged-particle beams is described. The unit will produce the most elaborate waveforms so far used in this type of experiment, and it can be modified to produce the simpler waveforms that suffice for a number of experiments. All waveforms are derived from a single train of input pulses so that no subsidiary timing circuits are employed. The circuit is an order of magnitude smaller and less expensive than those previously used. (auth) (UK)

22511 BLOCKING OF PLASMA STREAM BY TRANSVERSE MAGNETIC FIELD. Inoue, Kenji; Kunieda, Shunsuke (Japan Atomic Energy Research Inst., Ibaraki). Jap. J. Appl. Phys.; 10: 243-7(Feb 1971).

Under some operating condition of the coaxial plasma gun, the plasma stream ejected from the gun consists of two components, fast and slow. A test was made to remove the slow-component blob from the plasma stream by applying a fast-rising transverse magnetic field in the plasma-guiding space at a time when the fast-component blob has passed through the slow-component blob does not arrive. The slow-component blob is blocked by the fast-rising transverse magnetic field of 5000 G. The blocking ability of the oscillating transverse magnetic field is inferior compared to that of the quasi-static field, i.e., the oscillating magnetic field crowbarred at its first maximum. (auth)

22512 INTERACTION OF A LASER-BLOWOFF PLASMA WITH A STRONG TRANSVERSE MAGNETIC FIELD. Burnett, N. H.; Smy, P. R. (Univ. of Alberta, Edmonton). J. Appl. Phys.; 42: 991-4(1 Mar 1971).

The interaction of laser-blowoff metal plasmas with transverse magnetic fields in the 100-kG range was studied, the magnetic field being generated by a simple line current. Under these conditions it was found that the plasma crossed the field by means of an electrical polarization and $E \times B$ drift. An observed velocity reduction at fields greater than 10 kG was attributed to an inhibiting effect of the magnetic field on the normal ambipolar energy transfer between electrons and ions in the expansion of laser-blowoff plasmas. (auth)

22513 EXPERIMENTS ON THE BEHAVIOUR OF A PLASMA COLUMN IN A MAGNETIC FIELD. Toader, E. I. An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.; 16: 69-76(1967).

The behavior of the homogeneous cylindrically symmetric positive column in the presence of a longitudinal magnetic field was studied. Experiments were performed on helium and neon. The correlation of the critical magnetic field with the kind of gas, pressure, and tube radius yielded values that are in good

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agreement with those calculated by Kadomtsev and Nedospasov. (auth) (Rom. Sci. Abstr.)

22514 RADIATION-INDUCED INSTABILITY AND SUPPRESSION OF BERNSTEIN WAVES IN BEAM–PLASMA SYSTEM. Mizuno, K.; Sugaya, R.; Shioji, M.; Tanaka, S. (Kyoto Univ.). Phys. Lett.; 34A: 149-50(22 Feb 1971).

Experimental results presented show the suppression of unstable Bernstein waves and the enhancement of these modes by irradiation of a pump field. These effects are observed only when an electron beam is present in a magnetoplasma. (auth)

22515 PROCESSES OCCURRING IN DECAYING RARE GAS PLASMAS. Veatch, George Edward Jr. Minneapolis; Univ. of Minnesota (1970). 106p. University Microfilms Order No. 70-27,177.

Thesis.

The time dependence of the He^+ ion density was studied during the decay period of plasmas produced in helium and helium containing 5×10^{-3}% neon. The results show that during the early afterglow period the time dependence of the He^+ density is determined by the He^+ loss processes, while during the late afterglow period this time dependence may be governed by He^+ production due to mutual collisions between triplet metastable helium atoms. The experimental conditions for observing the influence of the He^+ production process on its decay rate are discussed. The properties of Ar^+ and Ar_2^+ were studied in helium–argon mixtures by means of the afterglow method. The time dependence of the number density of these ions was measured by mass-spectrometric techniques. The temporal behavior of the intensity of various spectral lines was also determined. The studies established the occurrence of the collisional recombination process $Ar^+ + 2e \rightarrow Ar + e + h\nu$, while they confirmed the importance of the dissociative recombination process $Ar_2^+ + e \rightarrow Ar + Ar + h\nu$. The collisional process appeared to populate all levels studied, while the dissociative process selectively populated the 2p and 3p energy levels. The only ion–molecule association reaction observed for argon concentrations between 0.01% and 5% was $Ar^+ + Ar + He - Ar_2^+ + He$. The rate constant was found to be 8.0×10^{-32} cm^6 sec^{-1}. The value of the mobility of Ar^+ in the helium–argon mixtures obeyed Blanc's Law. (TSS) (Diss. Abstr. Int., B)

22516 INELASTIC COLLISION PROCESSES IN GLOW DISCHARGES. Launey, Walton Sebastian Jr. Austin, Tex.; Univ. of Texas (1970). 210p. University Microfilms Order No. 71-154.

Thesis.

The relaxation mechanisms for the n = 3 excited states of helium were investigated in a direct-current glow discharge and in a pulsed afterglow. Particular emphasis was placed on determining the detailed nature of the energy exchange between the excited states by means of excitation transfer through electron and neutral atom collisions. Effective rate constants for the appropriate processes were deduced from the relative population density changes of the states involved. (TSS) (Diss. Abstr. Int., B)

22517 EXPERIMENTAL INVESTIGATION OF COUNTERSTREAMING PLASMAS. Soures, John Michael. Rochester, N. Y.; Univ. of Rochester (1970). 124p. University Microfilms Order No. 71-1431.

Thesis.

An experimental study of counterstreaming plasmas was conducted. In the first experiment, an aluminum, laser-produced plasma was allowed to expand into a background cesium plasma formed in a single-ended, pulsed emitter, Q machine. At background densities $\gtrsim 10^{10}/cm^3$, and in a magnetic field of about 100 gauss, considerable scattering of the laser plasma expanding along the cesium plasma column was observed for an interaction distance of about 6 cm. Consideration of various interaction mechanisms indicate that the scattering is due to an electrostatic, electron–ion, two-stream instability triggered by the thermalization of the laser plasma electrons with the electrons of the background plasma. In the second experiment, two aluminum, laser-produced plasmas, formed 7 cm apart, were allowed to expand into each other in the absence of an externally applied magnetic field. A small amount (~1%) of scattering was noted at 90° to the streaming as might be expected in the absence of any strong interactions. (Diss. Abstr. Int., B)

22518 EFFECT OF INELASTIC COLLISIONS ON THE ELECTRON DISTRIBUTION IN THE ELECTRODE SHEATH IN A WEAKLY IONIZED PLASMA. Baksht, F. G. (Semiconductor Inst., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1205-9(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1554-9(Jul 1970).

The energy relaxation of an electron beam from a cathode in a weakly ionized plasma is investigated. The beam is accelerated in the Debye sheath that surrounds the cathode. An analytic expression for the energy distribution function is derived for the case in which the relaxation is due to electron–electron and inelastic electron–atom collisions. Limiting cases are examined and the two relaxation mechanisms are compared. (auth)

22519 FLOW RATES OF PLASMA COMPONENTS IN A PULSED PLASMA ACCELERATOR. Derevshchikov, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1200-1(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1550-1(Jul 1970).

Flow rates of Al^+, Al^{++}, and C^{++} ions in a pulsed plasma accelerator are measured by the Doppler shift of the spectral lines. The data are then compared with results of similar measurements taken by high-speed scanning of the discharge in the monochromatic light of the spectral lines. (auth)

Kinetics (Theoretical)

Refer also to abstract 22481.

22520 CONTRIBUTIONS TO SOLVING THE LINEARIZED EQUATIONS OF MAGNETOFLUIDDYNAMICS BY THE FOURIER TRANSFORM METHOD. Ignat, M. An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ib. Fiz.; 16: 7-12(1970). (In Rumanian).

Lighthill's method relying on the multi-dimensional Fourier transform was extended to compressible nonstationary plasma with consideration of the dissipation effects. The method can be successfully used in the study of magnetohydrodynamic waves with various configurations. (auth) (Rom. Sci. Abstr.)

22521 POPULATION DENSITIES AND IONIZATION EQUILIBRIUM IN TWO-TEMPERATURE PLASMAS. Drawin, H. W. (CEN, Fontenay-aux-Roses, France). Phys. Lett.; 34A: 151-2 (22 Feb 1971).

Population densities of hydrogen levels calculated from a coupled system of rate equations are compared with those obtained by Suckewer from approximations to the rate equations. The results agree for $T_e = T_a$, and slight differences appear for low principal quantum numbers when the gas temperature T_a is different from the electron temperature T_e. (auth)

22522 HIGH-ORDER PERTURBATION THEORY FOR A ONE-ELECTRON ION IMMERSED IN A PLASMA. Iafrate, Gerald Joseph. Brooklyn; Polytechnic Inst. of Brooklyn.(1970). 85p. University Microfilms Order No. 70-26,065.

Thesis.

High-order Rayleigh–Schroedinger perturbation theory is developed and applied to model problems in plasma spectroscopy; namely, the separate problems of an electron bound in a screened Coulomb potential and a one-electron ion under the influence of a long-range proton. The solution to the nonrelativistic Schroedinger equation for the screened Coulomb potential is investigated by utilizing the large-Z (Z is nuclear charge) asymptotic expansion theory. Both the basic asymptotic and perturbation solutions are obtained. The problem of finding the k^{th} order perturbation wavefunction and energy for any state is reduced to solving, recursively, a set of k linear algebraic equations in k unknowns. The asymptotic expansion for the energy and wavefunctions are presented to the tenth order in perturbation theory for the 1S state and to fifth order for the general n, l = n – 1 quantum state. Results for the 2S state are also given. Comparison of the perturbation theory results with those of numerical integrations for the energy show excellent agreement. It is shown that a finite screening radius gives rise to a finite number of bound states, a result that contradicts some recently published work. Application of the screened Coulomb potential model to intensity cutoffs in the spectra of solar and laboratory hydrogen plasmas is discussed. It is shown that, although the screened Coulomb potential leads to a maximum value of occupied principal quantum number n^*, this value is much too large to explain observed intensity cutoffs. Results are also obtained for a one-electron ion under the static long-range influence of a proton. The energy and wavefunction are obtained to fourth order in perturbation theory (to the octopole moment) for the ground state and first excited state. A calculation of the Lyman-α series for this problem showed that noticeable intensity asymmetries were present, due mainly to quadrupole effects. The asymmetric behavior, characteristic of quadrupole interactions, has been experimentally observed in the literature and is discussed here. Finally, the solution to the nonrelativistic Schroedinger equation for a one-electron ion in a generalized central field potential is investigated using high-order perturbation theory. It is shown that by utilizing a finite expansion of the perturbation theory wave-

function in terms of associated Laguerre polynomials, perturbation theory results can be obtained for any n, l state to arbitrarily high order. Results for the wavefunction and energy are explicitly given to third and fourth order, respectively. It is also shown that by re-expressing the high order perturbation theory energy expansion as a series of rational fractions (Padé approximants), accurate eigenvalues are obtained, even for large values of the expansion parameter. (Diss. Abstr. Int., B)

22523 THEORY OF ELECTRON IMPACT BROADENING IN PLASMA. Tsuji, Akio; Narumi, Hajime (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 44: 1557-66(Dec 1970).

A quantum-mechanically consistent formulation of the theory of electron-impact broadening in plasmas is given by using the scattering matrices obtained from a closed-coupling procedure instead of the classical path approximation, where the indefinite parameter of the impact radius can be removed. Typical calculations of neutral and ionized radiators are carried out for the hydrogen system. (auth)

22524 EFFECT OF RADIATION DAMPING ON THE MOTION OF CHARGED PARTICLES IN AN INHOMOGENEOUS MAGNETIC FIELD. Gernet, G. E. (Leningrad Electrical Engineering Inst. of Communications). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1230-4(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1581-7(Aug 1970).

The motion of charged particles in an inhomogeneous magnetic field is discussed in the drift approximation taking account of radiation damping. The radiation damping causes drift of the guiding center along the Larmor radius. Since the Larmor radius decreases with time, however, the radiation drift and the drift due to the changes in the magnitude of the magnetic field decreases. There remains a drift due to the change of the field direction. Equations are found for the time dependence of the kinetic energy and the quantity $p_\perp^2/H$. The reflection of particles from a magnetic mirror is discussed. Radiation damping inhibits the decrease in the longitudinal momentum, permitting charged particles to escape from a magnetic trap. (auth)

22525 TRANSITION RADIATION IN INHOMOGENEOUS PLASMA. Haber, Irving. Brooklyn; Polytechnic Inst. of Brooklyn (1970). 146p. University Microfilms Order No. 70-26,057. Thesis.

The aim was to facilitate calculation of the transition radiation expected when an electron beam is shot through a laboratory plasma. The theory of transition radiation by an electron passing through a single sharp interface (half-space) and two parallel interfaces (slab) is generalized to include the effects of a parallel-plate conducting boundary. Extensive numerical calculations over a wide range of parameters are included to illustrate the detailed behavior. By using a multi-slab approximation, which rapidly converges to the continuous profile, numerical calculations are performed to investigate the effect on transition radiation when the boundary becomes diffuse. The continuous limit of the same multi-slab approximation is also taken analytically to yield a Bremmer series expansion for transition radiation from an inhomogeneous region. This series is found useful both in regions of rapid variation of dielectric constant and regions near critical density where previous methods were not applicable. It is shown that, as the boundary becomes increasingly diffuse, the transition radiation falls off rapidly until a limiting value is reached. A similar multi-slab treatment is also presented which investigates the excitation and propagation of a surface wave along the plasma-free space boundary. It is found that as soon as the boundary becomes at all diffuse, the surface waves become rapidly attenuated. A simple analytic calculation for a thin transition layer is presented which exhibits the region of high fields responsible for this attenuation, and is useful for understanding this behavior. (Diss. Abstr. Int., B)

22526 THEORY OF COHERENT CHERENKOV RADIATION PRODUCTION BY HIGH-INTENSITY ELECTRON BEAMS. Eastlund, B. J. (Atomic Energy Commission, Washington, D. C.). Nucl. Fusion; 11: 15-23(Jan 1971).

Coherent Cherenkov radiation can be generated by "bunched" or rapidly rising charged-particle beams that propagate in a background magnetoplasma in which the Cherenkov conditions are satisfied. It is shown theoretically that when such an electron beam is injected into an initially nonionized gas, the power radiated and the plasma produced by the radiation exhibits a tangent-function dependence on time. This abrupt rise in the power level of the radiation is also shown to produce significant electron energy loss. Results from various high-intensity electron-beam experiments are compared with the theory. The tangent-function dependence of radiation growth and the energy loss of electrons were observed. (auth)

22527 SOLUTION OF THE BOLTZMANN EQUATION FOR A FULLY IONIZED PLASMA IN AN OSCILLATORY ELECTRIC FIELD AND A STEADY MAGNETIC FIELD. III. Lupu, Gheorghe (Univ. of Cluj). Rev. Roum. Math. Pures Appl.; 15: 871-6(1970).

Using the results obtained in Part II, a method is presented for solving the systems of equations by expanding the distribution function after the powers of some dimensionless parameters suitably defined. The system of equations for the case of homogeneous plasma in a unidirectional oscillatory electric field is studied. (auth)

22528 INVARIANT OF THE FINITE-LARMOR-RADIUS THEORY. Bajaj, N. K. (Univ. of Maryland, College Park). Nucl. Fusion; 11: 63-5(Jan 1971).

In the context of the finite-Larmor-radius theory, an expressior for the particle adiabatic invariant is obtained that is correct to order ϵ^2, where $\epsilon = a/L$ (a being the ion Larmor radius and L any characteristic length of the system) is the expansion parameter. (auth)

22529 THERMODYNAMIC PROPERTIES OF NONIDEAL GASES. II. THE STRONGLY IONIZED GAS. Graboske, H. C. Jr.; Harwood, D. J.; DeWitt, H. E. (Univ. of California, Livermore). Phys. Rev., A; 3: 1419-31(Apr 1971).

The thermodynamic equilibrium properties of strongly ionized multicomponent gas mixtures are investigated by applicafion of the free-energy minimization method. For high-temperature regions where the Coulomb interaction is the dominant perturbation, the many-body partition function is developed from quantum cluster-expansion theory. The Coulomb free energy is given as the sum of the first- and second-order direct-interaction terms, plus the first three exchange-interaotion terms. All five terms are exact in the classical limit, i.e., where Maxwell–Boltzmann statistics apply. The direct terms are correct for weak electron degeneracy and include wave-mechanical effects, while the first-order exchange term is exact for all degrees of degeneracy. The theoretical model is applied to multicomponent mixtures of hydrogen and of helium in the temperature range 50 to 2000 eV. The combination of the ring term plus higher-order terms significantly extends the region of applicability of the model over a classical electrostatic model. Specifically, electron degeneracy, the short-range cutoff in the ring term, and the three-rung ladder (second-order direct) term all operate to produce much less divergent thermodynamic results at a given density and temperature. First-order exchange is important even at moderate values of the electron-degeneracy parameter. The thermodynamic results indicate that evaluation of the exact quantum-mechanical ring term is essential for wider application of the perturbation-expansion theory, as is the development of a second-order exchange term for arbitrary degeneracy. (auth)

22530 FINITE-TEMPERATURE RELATIVISTIC ELECTRON BEAM. Toepfer, A. J. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., A; 3: 1444-52(Apr 1971).

Moments of the relativistic Vlasov equation were taken over a Maxwellian distribution. The resulting fluid equations were coupled with Maxwell's equations and solved for an axially uniform cylindrically symmetric electron beam in the steady state. Magnetic neutralization and thermal conduction were neglected, and the beam was assumed to be charge neutralized in the observer's reference frame. The equilibrium was supported by radial gradients in particle pressure balancing against magnetic forces. With no externally applied magnetic field, or for a beam propagating parallel to a magnetic field with no rotation, the total current carried by the beam was found to be significantly less than the Alfvén critical current I_A, the ratio of beam current to I_A increasing with temperature and decreasing with increasing β. For a diamagnetic beam in an external field, a rigid-rotator model was assumed. Solutions of the steady-state equations were obtained for various values of rotation frequency ω and beam temperature. The radial density profiles were peaked on axis for small ω, and became hollow as ω increased, because of centrifugal forces. For all ω, the beam density was observed to exhibit radial oscillations which grew in amplitude and decreased in wavelength with decreasing temperature. Equilibria with magnetic field reversal were possible for all values of ω. Purely rotational self-consistent equilibria of the rigid-rotor type were not possible for a charge-neutralized beam of the type considered. (auth)

22531 SIMPLIFIED MODEL FOR IONIZATION AND RECOMBINATION IN A HYDROGENIC PLASMA WITH RESONANCE RADIATION TRAPPING. Mewe, R. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Z. Naturforsch.; 25a: 1798-1803(Dec 1970).

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The rate coefficients for electron collisional–radiative ionization and recombination were calculated on the basis of a simplified level scheme for hydrogenic ions in a homogeneous and fully contained plasma with self-absorption for (Doppler broadened) Lyman-α radiation. The energy distribution of the electrons is assumed to be Maxwellian. Photo-ionization is neglected. The calculation was done for a range of electron temperatures of Z^2 to 10 Z^2 eV and electron density of 10^{14} Z^7 to 10^{24} Z^7 m^{-3}, where Z is the charge number of the bare nucleus. (auth)

22532 ION-SLIP COEFFICIENTS FOR PARTIALLY IONIZED ARGON AND HELIUM. Wang, H. S. C. (Bell Aerosystems Co., Buffalo). Z. Naturforsch.; 25a: 1823-6(Dec 1970).

Ion-slip coefficients in Demetriades and Argyropoulos' generalized Ohm's law are studied quantitatively in the first approximation for partially ionized Ar and He under various nonisothermal gas conditions. The macroscopic forces due to collisions between electrons, ion, and neutral atoms are accounted for by averaging the momentum transfer cross sections over the Maxwellian velocity distributions of the colliding particles. To incorporate the appropriate interpolation and extrapolation techniques in the low-energy limit, Frost and Phelps' cross sections for electron–atom collisions and Dalgarno's value for ion–atom resonant charge-transfer cross sections are used. The weighted average momentum transfer cross sections thus obtained, which are also important in other diffusion and transport processes, are tabulated at various particle kinetic temperatures for both gases. A family of curves representing values of ion-slip coefficients calculated from these data is plotted. With the generalized Ohm's law written in its inverted form, the influence of ion-slip on the "Hall conductivity" in Kruger et al's formulation is discussed. (auth)

22533 COMPUTER STUDY OF NONEQUILIBRIUM EXCITATION IN RECOMBINING NITROGEN PLASMA NOZZLE FLOWS. Bowen, Stuart W. (Univ. of Michigan, Ann Arbor); Park, Chul. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: 493-9(Mar 1971).

The nonequilibrium neutral-atom excited-state densities, electron densities, and electron and heavy-particle temperatures are computed for a fully dissociated partially ionized nitrogen plasma expanding in a nozzle starting from equilibrium in the settling chamber. The degree of excitation nonequilibrium at the exit of a convergent–divergent nozzle having an area ratio of 22 is systematically investigated for chamber pressures between 0.01 and 1000 atm and chamber temperatures between 6000 and 18,000°K. Thermal nonequilibrium at the exit rises to a maximum in the chamber pressure range between 1 and 10 atm, whereas excitation nonequilibrium is smallest in this pressure range, due to the competing effects of the three-body recombination and collisional coupling terms in the electron energy equation. Increasing chamber pressure above 10 atm produces increasingly severe and unexpected departure from excitation equilibrium. (auth)

Production

Refer also to abstracts 22479 and 22531.

22534 HOT-ELECTRON PLASMA PRODUCED BY CYCLOTRON RESONANCE ABSORPTION. Patrushev, B. I.; Gozak, V. P.; Frank-Kamenetskii, D. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1058-62(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1363-70(Jul 1970).

Electron cyclotron heating of a plasma in a waveguide produces a group of hot electrons at an energy of 80 keV, together with a plasma with an energy of about 100 eV. The confinement times were measured by various methods. There is a sharp rise in the energy loss at certain plasma densities, with subsequent emission of pulses at harmonics of the cyclotron frequency. These effects are due to the formation of a reflecting layer, within the spatially inhomogeneous plasma, at which the refractive index becomes zero. (auth)

22535 TEMPERATURE AND EXPANSION ENERGY OF LASER-PRODUCED PLASMAS. II. EXPERIMENTS. Puell, H.; Neusser, H. J.; Kaiser, W. (Technische Univ., Munich). Z. Naturforsch.; 25a: 1815-22(Dec 1970).

Experiments on laser-produced plasmas with light intensities between 2×10^{11} and 5×10^{12} W/cm^2 are reported. Measurements of the electron temperature and the expansion energy were performed. In the case of LiD targets the highest temperature observed was 200 eV; using carbon targets a maximum temperature of 330 eV was measured. The corresponding expansion energies reach values as high as 13 keV. The experimental results are in good agreement with a stationary, hydrodynamic theory. It was concluded that, in these LiD and C plasmas, ions and electrons have the same temperature. (auth)

22536 DETERMINATION OF THE ENERGY BALANCE OF A PULSED PLASMA SOURCE. Koehne, R.; Meert, A. (Deutsche Forschungs und Versuchsanstalt fuer Luft und Raumfahrt, Stuttgart). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: 518-20 (Mar 1971).

Helium gas was ionized and accelerated in a pulsed inductive accelerator, and the particle temperature, plasma velocity, and damping were measured spectroscopically for charging voltages U between 10 and 15 kV. Total and absorbed energies were determined, and the energy balance among ionization, plasma heating, and kinetic energies is presented as a function of U. The power requirement for the source was estimated to be between 5 and 50 kW, with the effective efficiency of energy transfer being 60 to 90%. (D.L.C.)

22537 PRODUCTION OF NET FUSION ENERGY FROM LASER-HEATED TARGET PLASMAS. Johnson, Roy R.; Hall, Richard B. (Boeing Scientific Research Labs., Seattle). J. Appl. Phys.; 42: 1035-9(1 Mar 1971).

The heating of a small particle of deuterium–tritium by laser radiation is considered, and conditions for energy gain are determined. The size of the D–T particle for a balance of energy input and neutron energy output is computed as a function of initial plasma temperature. The electrical energy required for this breakeven condition is shown and increases as the inverse fourth power of laser efficiency. Because electrons are first heated by the laser radiation and then must transfer their energy to ions by collisions, a computation of electron–ion thermalization is presented. These results show that electron–ion thermalization through collisions applies a severe limitation on most cases for producing net fusion energy and must be considered in a consistent manner for smaller particles. (auth)

22538 ELLIPSOIDAL PLASMA CONFIGURATIONS. Rashkovan, V. M.; Khizhnyak, N. A. (Kharkov Aviation Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1071-6(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1382-9(Jul 1970).

The formation of a stable plasma configuration that is an ellipsoid of rotation in a system of alternate positive and negative annular electrodes in a longitudinal magnetic field is considered. A theoretical solution is given for the stability of such plasmoids with an uncompensated charge in static E and H fields. It is shown that plasmoids in such a system exist stably in the form of a prolate or oblate ellipsoid of rotation. Stable plasma configurations were obtained experimentally in the alternate-electrode system at pressures of 10^{-3} to 10^{-4} mm Hg. The geometric dimensions of the plasma ellipsoids are shown to depend, to a large extent, on the voltage applied to the electrodes, the pressure, and the longitudinal magnetic field. (auth)

22539 SYNTHESIZED CESIUM PLASMA BEAM. I. Golovanivskii, K. S.; Lushchik, A. I. (Patrice Lumumba Univ., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1149-54 (Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1490-6(Jul 1970).

Capture of electrons emitted by an external source, in a beam of positive cesium ions accelerated to energies of 60 V, is studied experimentally. The experiments were conducted in the pulsed mode (pulse widths 2.3 msec). It is shown that when the neutralizer potentials are positive, the electrons are not carried to the collector by the beam, but only neutralize the space charge of the beam. When the emissivity of the neutralizer is sufficiently high the electrons are emitted into the beam only during the time before the front of the ion beam has reached the collector. There is no automatic entrainment of electrons by the ion beam (i.e., no automatic neutralization of the current). (auth)

22540 INITIAL ARGON IONIZATION BEHIND A SHOCK FRONT. Smekhov, G. D.; Lobastov, Yu. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1991-3(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1660-3(Aug 1970).

The initial argon ionization behind a shock front is studied by a microwave method. The ionization is shown to be a two-stage process in atom–atom collisions. (auth)

22541 IONIZATION GROWTH IN A PLASMA. Reich, Allen Donald Jr. Evanston, Ill.; Northwestern Univ. (1970). 170p. University Microfilms Order No. 71-1948.

Thesis.

The ionization rate is calculated for a slightly ionized gas subject to a high-frequency, electric field. A Boltzmann equation is developed that includes elastic, excitation, and ionization collisions between electrons and neutral atoms. The spherical harmonic expansion of this equation is developed, and the electron distribution function, f, is obtained from the zero and first order equations of the expansion. Analytical and numerical de-

terminations of f and the ionization rates obtained from f are compared at several levels of model refinement. The study focuses upon the electron to neutral mass ratio, δ, as a crucial parameter in the ionization process. It shortens the time required for the ionization rate to become steady after the field is turned on. It causes the ionization collisions to dominate above the ionization, threshold speed. This, in turn, prevents most of the electrons from reaching higher speeds even with higher fields. Finally, δ plays a central role in the basic formulation of the problem. It produces a rapid convergence in the orders of the spherical harmonic expansion. Other techniques use an integral equation approach to deal with high fields. By introducing δ into these techniques, it is shown that they are reconciled with the spherical harmonic expansion. (Diss. Abstr. Int., B)

Stability

Refer also to abstracts 22323 and 22508.

22542 INSTABILITIES IN A PLASMA COEXISTING WITH A LARGE-AMPLITUDE WAVE. Manheimer, Wallace M. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., A; 3: 1402-16(Apr 1971).

The stability of a periodic large-amplitude electrostatic wave [Bernstein–Greene–Kruskal (BGK) mode] in a collisionless plasma is investigated. It is found that instability or damping can result whenever a wave has a frequency which is resonant with one of the natural frequencies of a particle in the BGK mode. The total growth or damping rate is expressed as a summation over these resonances. In appropriate limits, the growth rates are identical with those corresponding to linear and nonlinear Landau damping. Three specific problems are considered. Electron plasma waves in a plasma at thermal equilibrium are shown to be unstable toward decay into an ion acoustic wave. Plasma waves in an electron-beam–plasma system are shown to be unstable toward decay into ion waves. Finally, an electron-plasma wave at frequency ω_0 is shown to be unstable toward decay into the lower sideband, i.e., a wave at $\omega_0 - \omega_T$ where ω_T is the trapping frequency. (auth)

22543 INFLUENCE OF A COLLISIONAL PLASMA BACKGROUND ON CLASSIFICATION OF THE TWO-STREAM INSTABILITY. Infeld, E. (Inst. of Nuclear Research, Warsaw). Nucl. Fusion; 11: 33-6(Jan 1971).

A general method is discussed for finding the line of marginal absolute instability and lines of equal asymptotic growth rates in parameter space for streams and a collisional plasma when the stability analysis for the same problem without plasma is known. The region of absolute instability is seen to be diminished whenever $\nu \neq 0$ (collision frequency $\neq 0$). For $\nu = 0$, the plasma background does not change the region of absolute instability, but growth rates are diminished. For this case and two cold streams the asymptotic growth rates are found analytically. Previous results are seen to be too narrow and singular to give an adequate picture of what is happening. (auth)

22544 STABILIZATION OF SOME DISSIPATIVE INSTABILITIES BY MEANS OF hf ELECTROMAGNETIC FIELDS. Ivanov, A. A.; Teichmann, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 19: 941-55(1969).

The stabilizing effect of an hf electromagnetic field is studied in the case of dissipative instabilities. It is shown theoretically that a decrease of the growth rate of several instabilities takes place. An explanation of the new stabilizing mechanism is presented. (auth)

22545 LIMITS OF THE INSTABILITY OF TRAPPED PARTICLES IN A FINITE-PRESSURE PLASMA IN TOROIDAL SYSTEMS. Kursakov, V. N. At. Energ. (USSR); 29: 388-9(Nov 1970). (In Russian).

Because of the direction of the magnetic drift, the trapped particles in the Tokamak-type toroidal systems may exhibit an instability, it was attempted to stabilize this instability in a finite-pressure plasma. An expression was derived for the mean velocity of the total (diamagnetic and magnetic) drift of trapped particles, obtaining a system of algebraic equations for the determination of the limits of instability. This made it possible to find the conditions under which the plasma is stable. The instability disappears when, in the course of the development of the perturbation, the portion of the trapped particles with a favorable total drift is larger than the portion of particles with an unfavorable drift; this condition is defined. (TTT)

22546 STABILITY OF A PLASMA WITH ANISOTROPIC DISTRIBUTION FUNCTIONS IN A MAGNETIC FIELD. Anokhin, S. B.; Kindrat'ev, A. S. Vestn. Leningrad. Univ., No. 10, Fiz., Khim.; No. 2, 17-21(May 1970). (In Russian).

It is shown that plasma with anisotropic distribution functions in a stationary homogeneous magnetic field is stable in regard to potential oscillations at $\vec{k} \| \vec{H}$. Sufficient conditions of stability at $\vec{k} \perp \vec{H}$ are obtained. (auth)

22547 EFFECTS OF a.c. ELECTRIC FIELD ON TEMPERATURE GRADIENT DRIFT INSTABILITIES. Curatolo, M.; Dobrowolny, M. (EURATOM–CNEN, Frascati, Italy). Lett. Nuovo Cim.; 1: 162-4(23 Jan 1971).

The analysis is carried out for the two frequency regimes: $v_i < \omega/k_{\|} < v_e$ and $\omega/k_{\|} < v_i$, where ω is the wave frequency, $k_{\|}$ the wave vector component parallel to the magnetic field, and $v_j = (2kT_j/m_j)^{\frac{1}{2}}$ (j = i, e for ions and electrons, respectively) the thermal velocities. The stabilizing effects are briefly discussed. (M.O.W.)

22548 DIFFUSION BROADENING OF A PLASMOID IN A LONGITUDINAL MAGNETIC GUIDE FIELD. Khizhnyak, N. A. (Kharkov Aviation Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1264-9(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1625-31(Aug 1970).

The stability of a parabolic particle distribution in a plasmoid is examined under the conditions of nonlinear diffusion arising from electron–ion collisions. The effect of volume recombination, charge exchange, and longitudinal thermal expansion of the plasmoid on the density and the plasma–magnetic field boundary are also investigated. (auth)

22549 CYCLOTRON INSTABILITY IN AN ADIABATIC MAGNETIC TRAP. Pereverzev, G. V. (Moscow State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1037-42(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1337-45(Jul 1970).

A study was made of the cyclotron instability in traps with particle beams that move parallel to the magnetic field. Analytic and numerical methods are used to plot the instability regions on the parameter plane representing the plasma density $\omega_{0e}^2/\omega_{He}^2$ versus the anisotropy of the ion distribution function $\epsilon_{\perp\|}/T_{\|\|}$. The growth rates are calculated. The results of the numerical calculation are compared with experiments conducted in the AS apparatus. The critical density above which the cyclotron instability develops in the apparatus is found to be in good agreement with theoretical predictions. Analysis of the instability regions shows that threshold cyclotron oscillations develop in the AS apparatus as a result of ion temperature anisotropy and depend only slightly on the specific form of the ion velocity distribution. (auth)

Thermonuclear Processes

22550 SOME CONSIDERATIONS ON THE ECONOMICS OF TRIGGERED FUSION REACTIONS. Eden, M. J.; Saunders, P. A. H. (Culham Lab., Abingdon, Eng.). Nucl. Fusion; 11: 37-41(Jan 1971).

The economics of a pulsed fusion reactor, relying on inertial confinement and using solid D–T pellets as fuel, are briefly discussed. An estimate of the minimum size for such a reactor is calculated for a range of energy gains. The improvements resulting from enclosing the fuel pellet within a solid tamper and using the alpha-particle energy to heat the plasma are considered. The trigger energies required are found to be around 10^3 MJ, to be injected in a few nanoseconds. (auth)

22551 LITHIUM HYDRIDE PARTICLE INJECTOR FOR LASER PLASMA EXPERIMENTS. Dolgov-Savel'ev, G. G.; Karnyushin, V. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 889-90(May–Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 220-2(May–Jun 1970).

An arrangement devised for experimental verification of an electrostatic method of injecting lithium hydride powder particles into the focusing region of the emission of a solid-state laser is described, and experimental results are reported. (auth)

Wave Phenomena

Refer also to abstract 22542.

22552 OSCILLATIONS OF BOUNDED COLLISIONLESS PLASMA. Lovetskii, E. E.; Silakov, V. P. (Moscow Inst. of Engineering Physics). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 13: 1486-9(1970). (In Russian).

The surface-drift and current-convective oscillations of a cylindrical collisionless plasma are studied. The influence of the conducting housing on these oscillations is taken into account. It is shown that, in some cases, surface oscillations are excited before corresponding shortwave oscillations. (auth)

22553 ABSORPTION OF ELECTROMAGNETIC WAVES IN BOUNDED MAGNETOACTIVE PLASMA. Bogomolov, Yu. V. (Radio-Technical Inst., Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 13: 1490-5(1970). (In Russian).

The oblique incidence of an electromagnetic wave on a semi-bounded magnetoactive plasma is considered. The constant magnetic field is parallel to the plasma boundary. The electric wave vector is perpendicular to the incidence plane and parallel to the constant magnetic field. The spatial dispersion is assumed weak. The absorption coefficient of a wave at mirror reflection of electrons from the plasma boundary was calculated. The absorption is shown to depend on the sign of the wave incident angle. (auth)

22554 ASYMMETRY OF COMBINATION FREQUENCY SPECTRA IN A BOUNDED PLASMA. Rutkevich, B. N.; Fedorchenko, V. D.; Muratov, V. I. (Physical-Technical Inst., Kharkov). Nucl. Fusion; 11: 51-6(Jan 1971).

The effects resulting in the asymmetry of combination frequency spectra observed when high-frequency and low-frequency oscillations interact in a plasma column are studied. Asymmetric spectra are the result of amplitude and phase modulation of a high-frequency wave. The phase modulation is due to the dependence of the wave number on the plasma density and velocity of motion of the electrons in the low-frequency wave field. The amplitude modulation is produced by the action of two mechanisms, one of which is associated with transverse motion of the plasma (with respect to the axis of the system), while the second is related to the instability of the system relative to the high-frequency oscillations. (auth)

22555 PROPAGATION OF MAGNETO-ACOUSTIC WAVES INSIDE MAGNETIC PLASMA TRAPS. Deutsch, R. V.; Grosu, I.; Zoler, D. (Polytechnical Inst., Iasi). Nucl. Fusion; 11: 57-61 (Jan 1971).

The propagation of magneto-acoustic waves in plasma traps is studied by making use of the methods of geometrical optics. It shows that annular traps, whose axis is the symmetry axis and in which magneto-acoustic waves can be concentrated, exist in the magnetic plasma traps such as are used in experiments aiming at the achievement of nuclear reactions. These traps are the domains enclosed by the surfaces U/r = const. or U = const., where U is the Alfvén velocity and r the cylindrical coordinate, depending on the symmetry of the problem. The structure and fundamental properties of these domains are studied for five special models. (auth)

22556 OVERSTABILITY OF COLD PLASMA WAVES. Gratton, F.; Gratton, J.; Sanchez, J. (Univ., Buenos Aires). Nucl. Fusion; 11: 25-32(Jan 1971).

The dielectric operator for nonhomogeneous plane-parallel cold plasma flows in an external magnetic field is given. The potential oscillations of two sliding plasmas are investigated. Expressions for the energy transfer between the plasmas and the energy of the modes are derived. A group-velocity analysis shows that pair emission of negative and positive energy waves occurs for modulation along the flow. Transverse modulation leads to an overstability of the system. A relation between the radiated plasma resonances and the overstability is worked out. Regions of existence and properties of the unstable modes are discussed in detail. For oblique modulations the regions of existence of unstable modes show marked departures from the already-known results for parallel modulation. (auth)

22557 UNTRAPPING OF ELECTRONS IN LONGITUDINAL PLASMA OSCILLATIONS. Hirsch, Ronald Henry. Evanston, Ill.; Northwestern Univ. (1970). 143p. University Microfilms Order No. 71-1868.

Thesis.

Two mechanisms for untrapping of electrons in longitudinal plasma oscillations are studied. The mechanisms are (1) collisions and (2) the presence of multiple modes. The combined nonlinear and collisional effects are considered using the classical Lorentz gas model to represent electron–ion and electron–neutral collisions. A perturbation analysis based on Montgomery's expansion technique is used. Three types of collisions are considered; hard elastic spherical particle collisions, collisions between particles interacting with an inverse fifth-power law, and collisions between particles interacting with an inverse square law. The modified Landau poles for a Maxwellian plasma are found. The first-order electric field and spatially homogeneous distribution function are found in terms of the collision parameters, wavelength λ, and wave amplitude ϵ. The collisional damping and the time dependence of the second-order spatially homogeneous distribution are found in each case. It is shown for the case considered that inverse-square interactions are most effective in relaxing the distribution function to equilibrium for comparable values of the collisional damping while rigid-sphere collisions are the least effective. The deformation of the potential trough by waves traveling at different phase velocities is studied in terms of the excitation and saturation of unstable plasma modes. A numerical solution of the Vlasov and Poisson equations neglecting mode coupling is used to study the validity of quasi-linear theory, which always predicts that the energy spectrum ultimately becomes steady-state. The Landau pole loci are found for a "bump-on-the-tail" Maxwellian distribution. The results show that, if the initial conditions are selected to meet the criteria of quasi-linear theory, the numerical solution agrees qualitatively with the predictions of quasi-linear theory. (Diss. Abstr. Int., B)

22558 LONGITUDINAL OSCILLATIONS OF A LORENTZIAN ELECTRON GAS. Lee, William Wei-li. Evanston, Ill.; Northwestern Univ. (1970). 99p. University Microfilms Order No. 71-1900.

Thesis.

The combined nonlinear and collisional effects on longitudinal electron oscillations are studied in terms of the Lorentz gas model assuming hard spherical particles. A perturbation analysis of the nonlinear kinetic equation is carried out following Montgomery's expansion technique. The modified Landau poles for initially Maxwellian plasmas are determined. The first order electric field and the second order spatially homogeneous distribution function are evaluated in terms of the inverse mean free path a, wavelength λ and initial perturbation amplitude ϵ. The collisional damping of the electric field and the time dependence of the spatially homogeneous distribution function in the resonance region resulting from hard-sphere collisions between electrons and neutral particles are studied. It is thought that this collision model is applicable to weakly ionized gases and can represent electron–neutral interaction for temperatures of a few electron volts. (Diss. Abstr. Int., B)

22559 PARAMETRIC EXCITATIONS IN BOUNDED PLASMAS. Demokan, Ordal. Iowa City, Iowa; Univ. of Iowa (1970). 108p. University Microfilms Order No. 70-23,880.

Thesis.

The problem of parametric excitations in bounded plasmas is treated both theoretically and experimentally. This treatment includes the nonlinear behavior that results when the plasma is in the presence of a strong external time-varying electromagnetic field. In the theory for excitation of the subharmonic oscillations of the incident time-varying electromagnetic field and frequency shifts, a modified form of Duffing's equation is used to model the longitudinal electric field in a plasma. Furthermore, Vlasov and fluid equations are used to show the excitation of low frequencies due to the frequency shift obtained from the above analysis. Two major groups of experiments are discussed; the first describes the one-half, one-third, and one-fourth subharmonic generation, their power relations with the incident signal, and the frequency shifts related to the incident power; the second describes the excitation of ion-acoustic waves, observation of their discrete modes for discrete power levels of the incident signal, and the frequency shift related to the incident power. In all these experiments, a mercury vapor discharge column, placed in a waveguide such that both the external electric field vector and the direction of propagation are perpendicular to the axis of the column, was used. (Diss. Abstr. Int., B)

22560 SEMI CLASSICAL THEORY OF PLASMA OSCILLATIONS. Guidone, Raffael John. Brooklyn; Polytechnic Inst. of Brooklyn (1970).

Thesis.

A general method for solving the coupled Vlasov–Maxwell equations that describe the plasma resonance problem is considered, and the formulation of these coupled equations for a bounded plasma with an arbitrary distribution function is given. The choice of the Fermi–Dirac distribution is analyzed in three useful limits depending on the parameter $C = \epsilon_f/kT$ (ϵ_f = Fermi Energy, k = Boltzmann constant, T = Temperature). If $C \ll 1$ the Fermi–Dirac distribution goes over to the classical limit (Maxwellian), and the use of the Maxwellian distribution in the Vlasov–Maxwell equations leads to the LTE (Low Temperature Expansion). For $C < 1$, the Fermi–Dirac distribution may be expanded as a power series in C, and the use of this expansion results in the SCLTE (Semi-Classical Low Temperature Expansion). Note the SCLTE goes over to the LTE when $C = 0$. For $C > 1$, the true Fermi–Dirac distribution resulting in the XLTE (Extended Low-Temperature

Equation) was used. All three theories (LTE, SCLTE, XLTE) result in eigenvalue equations with the eigenvalues being the resonant frequencies and the eigenfunctions the electric fields at resonance. Landau-damping formulas are also derived in terms of the electric fields and resonant frequencies. (Diss. Abstr. Int., B)

22561 CONTRIBUTIONS TO THE THEORY OF MAGNETO-HYDRODYNAMIC WAVE PROPAGATION THROUGH A COMPRESSIBLE ELECTRODUCTIVE FLUID. I. Ignat, M. An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ib. Fiz.; 15: 7-13(1969). (In Rumanian).

Considering the case of a compressible electroconductive fluid in slow motion under the action of a uniform magnetic field $\vec{H}_0$, and using the Clebsch theorem, the following equation is developed for the slow motion of a compressible fluid:

$$\frac{\partial^4\psi}{\partial t^4} - (V_a^2 + V_s^2)\frac{\partial^2\Delta\psi}{\partial t^2} + V_a^2V_s^2\frac{\partial^2\Delta\psi}{\partial z^2} = 0$$

where V_a = propagation velocity of Alfvén waves and V_s = sound velocity. The wave velocity $\vec{v}$, the induced magnetic field $\vec{h}$, the density ρ, and the pressure p are also obtained. The method is applied to the case of an infinite circular cylinder. (Rom. Sci. Abstr.)

22562 ALFVEN WAVES FOR THE PLASMA IN THE FIELD OF A MAGNETIC MONOPOLE. Petrus, O. An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ib. Fiz.; 15: 15-21(1969).

The problem of Alfvén wave propagation in a plasma system placed in the magnetic field of a magnetic monopole is solved by Weinberg's method (the eikonal approximation in magnetohydrodynamics). The excitation condition of the Alfvén module is found and so are the amplitude, phase, and group velocities of Alfvén waves. (auth) (Rom. Sci. Abstr.)

22563 SYNTHESIZED CESIUM PLASMA BEAM. II. Golovanivskii, K. S.; Lushchik, A. I. (Patrice Lumumba Univ., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1155-8(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1497-1500(Jul 1970).

The excitation of longitudinal electrostatic waves in a space-charge-neutralized synthesized plasma is studied experimentally. It is shown that the thermal electrons are accelerated, while the electrons injected into the beam that excite ion electrostatic waves are slowed down. As a consequence, the electrons automatically acquire a directed velocity equal to the velocity of the ion component (this constitutes current neutralization). (auth)

22564 SOLITARY WAVES IN A COLD THREE-COMPONENT PLASMA CONTAINING NEGATIVELY CHARGED IONS. Pataraya, A. D. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1227-9(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1577-80(Aug 1970).

The existence of a modulated solitary compression wave that propagates at an angle to the external magnetic field in a three-component plasma containing electrons and positively and negatively charged ions is established. The electron inertia is not taken into account. The structure of a modulated solitary compression wave of large amplitude that propagates along the magnetic field is also studied. A relation is established between the maximum magnetic field and the Mach number; the range of variation of the Mach number is determined. (auth)

22565 OSCILLATIONS OF A MAGNETIZED PLASMA IN A STANDING WAVE (TE MODE). Kostyukova, Yu. S.; Nekrasov, F. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1077-80 (Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1390-5(Jul 1970).

The stability of the oscillations of a magnetized plasma in a standing wave (TE mode) was studied. The frequency of the TE wave Ω_0 is assumed to be below the electron and ion cyclotron frequencies calculated for the constant magnetic field, and the intensity of the alternating magnetic field is assumed to be much smaller than that of the constant field. Only electrostatic perturbations are considered. The TE wave is shown to have essentially no effect on the low-frequency, long-wavelength oscillations. In the high-frequency, short-wavelength range, the TE wave causes parametric buildup of oscillations whose eigenfrequencies ω_0 (without the TE wave) are related to Ω_0 by $\omega_0^2 = r^2\Omega_0^2/4$ (r = 1, 2, 3, ...). Parametric resonances of plasma–electron and –ion oscillations are studied in the first instability region (r = 1) where the band width and increment are a maximum. (auth)

22566 PLASMA RESPONSE TO A STEP ELECTRIC FIELD GREATER THAN THE CRITICAL RUNAWAY FIELD, WITH AND WITHOUT AN EXTERNALLY APPLIED MAGNETIC FIELD. Robin, James Edmond. Los Angeles; Univ. of California (1970). 90p. University Microfilms Order No. 71-688.

Thesis.

The nonlinear response of a photoionized afterglow argon plasma subjected to a step electric field, E_0, of the order of 10^{-2} V/cm, but greater than the critical runaway field, E_r, i.e., $1 < E_0/E_r < 80$, was investigated. The research was divided into two basic parts. The electron current behavior was investigated in a magnetic field free plasma and then again in the presence of an externally applied magnetic field. The experiments were performed within the following range of parameters: $4 \times 10^8/cm^3 < n < 4 \times 10^9/cm^3$ and $T_e/T_i \simeq 13$ ($T_e \simeq 0.34$ eV and $T_i \simeq 1/40$ eV). (TSS) (Diss. Abstr. Int., B)

22567 THERMAL CORRECTIONS TO THE THEORY OF THE ION-ELECTRON LOWER HYBRID RESONANCE. Arumi, Francisco Noe. Austin, Tex.; Univ. of Texas (1970). 226p. University Microfilms Order No. 71-91[illegible].

Thesis.

A linear model of a warm, collisional, partially ionized plasma immersed in a static magnetic field and confined to half-space is developed to determine the temperature effects on the power absorbed by a radio-frequency plasma in the region of the ion–electron lower hybrid resonance. The results are compared with experimental measurements and the corresponding calculations based on a cold plasma model. Linear temperature and finite Larmor radius effects are introduced by calculating the stress tensor from the second moment of the Boltzmann equation, and by expanding the mobility tensor to keep terms linear in the temperature. The charged particles are contained by the magnetic field and the neutral particles by a rigid, transparent wall. The charged particles and the wall interact through the electron–neutral momentum transfer collisions. The plasma solutions are matched to the vacuum solutions, subject to the boundary constraints, through a set of boundary conditions derived from the total fluid conservation equations. Power absorption calculations show a peak at low magnetic fields in the same place where similar peaks have been observed experimentally and could not be accounted for with a cold plasma model. The parametric behavior of this peak reproduces the experimental behavior of the noise onset associated with this peak. The power absorption efficiency of the lower hybrid resonance is predicted to decrease with increasing electron temperature. (Diss. Abstr. Int., B)

22568 ELECTROMAGNETIC PLASMA WAVE PROPAGATION ALONG A MAGNETIC FIELD. Olson, Craig Lee. Los Angeles; Univ. of California (1970). 268p. University Microfilms Order No. 71-671.

Thesis.

The steady-state excitation of transverse plasma waves along a magnetic field was studied. The linearized response of a Vlasov plasma to the steady-state excitation of transverse plasma waves along an external magnetic field is examined. Previous research is reviewed. Steady-state transverse plasma wave echoes are next studied. The phenomenon of plasma wave echoes, introduced by Gould, Malmberg, O'Neil, and Wharton for the case of longitudinal electrostatic waves, is extended to the case of transverse plasma waves that propagate along an external magnetic field. It is shown that a transverse echo results in lowest order only when one excitation is transverse and the other is longitudinal. For this case, the second-order (nonlinear) plasma echo response is computed from the Vlasov–Maxwell equations up to an integral over the velocity variable v_z. Transverse echo characteristics are discussed and several experiments are suggested. The integral over v_z is evaluated by the method of steepest descent; the results are explained physically and also evaluated numerically for some specific cases. Several extensions are considered: (1) effects of Fokker–Planck collisions and finite-width excitation mechanisms, (2) effects of temperature anisotropy ($T_\perp \neq T_\parallel$), and (3) effects of propagation just off-axis ($k_\perp \neq 0$). Lastly, transverse echoes for the case of no external magnetic field are examined. (TSS) (Diss. Abstr. Int., B)

Shielding

Refer also to abstracts 21506, 22618, 22620, 22945, and 23328.

22569 (EGG-1183-1458(Pt.2)) COHERENT AND INCOHERENT X-RAY SCATTERING FACTOR FOR HELIUM AND TWO-ELECTRON ATOMIC IONS. PART II. Report No. L-968. Brown, Robert T. (EG and G, Inc., Las Vegas, Nev.). 1 Dec 1969. 9p. Dep. NTIS.

Values of the atomic form factor F(K) and the incoherent scattering function S(K) at low values of the momentum transfer

XUM

K are tabulated for the helium isoelectronic sequence through Z = 10. (A.G.W.)

22570 (SC-RR-70-427) PULSED ELECTRON BEAM ENERGY DEPOSITION PROFILES USING SOLID RADIATION SENSITIVE PLASTICS. Harrah, L. A. (Sandia Labs., Albuquerque, N. Mex.). Jun 1970. 24p. Dep. NTIS.

Deposition profiles for pulsed electron beams in solid radiation-sensitive plastics were measured; they indicate a pronounced range shortening at charge fluences greater than 0.5 $\mu C/cm^2$. This range shortening, due to charge trapping and the attendant internal field, reaches a constant value in the absence of apparent breakdown, which is independent of charge fluence at current densities greater than 33 A/cm^2 for mean electron energies of 1.35 MeV. The dose depth profiles at charge fluences greater than 0.5 $\mu C/cm^2$ exhibit a linearly decreasing back edge, which extrapolates to approximately 35% of the low fluence range and a low intensity tail extending to greater than 55% of this range. As the charge fluence increases, the tail of the dose profile decreases in relation to the forward portion. These phenomena are interpreted in terms of a charge-deposition model including radiation-induced conductivity. (auth)

22571 (ZJE-93) APPROXIMATION OF LINEAR COEFFICIENTS μ AND μ_a FOR GAMMA-RAY BY A TWO-DIMENSIONAL POLYNOMIAL. Valenta, V.; Vlachovsky, K. (SKODA Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 28p. Dep. NTIS (U. S. Sales Only).

Approximate expressions for the total mass coefficient $[\mu(E,Z)/\rho]$ and the mass coefficient $[\mu_a(E,Z)/\rho]$ are included for absorbed energy of gamma rays for atomic numbers Z = 1 to Z = 92 for two ranges of energy E = 0.2 to 2 MeV and E = 2 to 15 MeV. (auth)

22572 IMPORTANCE SAMPLING IN THE THEORY OF RADIATION TRANSMISSION. Khisamutdinov, A. I. Zh. Vychisl. Mat. i Mat. Fiz.; 10: 999-1005(1970). (In Russian).

The application of importance sampling is considered in radiation transport theory for the random value $\xi_0 = \Sigma_{k=1}^{n}\varphi(\alpha_k)$, where $\varphi(\alpha)$ is the weighting function of $\alpha_1 \ldots \alpha_n$ — the sequence of points of collisions in the trajectory. It is shown how to develop the method and obtain the standard deviation limits for the case when an approximate importance function is used. (tr-auth)

22573 QUANTUM THEORY OF ELECTRON ENERGY LOSS SPECTRA IN THIN FILMS. Lucas, A. A.; Sunjic, M. (International Centre for Theoretical Physics, Trieste, Italy). Solid State Commun.; 8: 1889-92(15 Nov 1970).

An exact theory of the interaction of a fast electron with plasmons in thin films is presented. The general shape of the electron energy-loss spectrum is described briefly. Multiple surface plasmon excitations are shown to be important for the specularly reflected beam at grazing incidence. (auth) (UK)

22574 SILICON DETECTOR MEASUREMENTS OF ENERGY DEPOSITION IN ALUMINUM BY MONOENERGETIC ELECTRONS. Chappel, S. E.; Humphreys, J. C. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 272-7(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The energy deposited at various depths in aluminum by incident monoenergetic electrons was measured with a silicon-semiconductor, transmission detector. Beams of monoenergetic electrons with incident energies of 0.50, 0.75, and 1.0 MeV were directed normally on a semi-infinite slab of aluminum in which a 0.196-mm silicon detector was positioned at various depths. The pulse-height distributions recorded with the detector were converted to absorbed-energy distributions from which the probability of energy absorption per incident electron in the specific layer, as well as the absorbed energy as a function of depth in the material, could be determined. The curves of absorbed energy as a function of depth obtained for aluminum at each energy were compared with those calculated by Berger and Seltzer, employing a Monte Carlo method. Good agreement is shown between calculations and measurements. (auth)

22575 PULSED ELECTRON BEAM ENERGY DEPOSITION PROFILES USING SOLID RADIATION SENSITIVE PLASTICS. Harrah, L. A. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 278-83(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The deposition profiles for the pulsed electron beams in solid radiation-sensitive plastics were measured and indicate a pronounced range shortening at charge fluences greater than 0.5 microcoulombs/cm^2. This range shortening, due to charge trapping and the attendant internal field, reaches a constant value in the absence of apparent breakdown that is independent of charge fluence at current densities greater than about 33 A/cm^2 for mean electron energies of 1.35 MeV. The dose depth profiles at charge fluences greater than 0.5 microcoulomb/cm^2 exhibit a linearly decreasing back edge that extrapolates to approximately 35% of the low-fluence range and a low-intensity tail extending to greater than 55% of this range. As the charge fluence increases, the tail of the dose profile decreases in relation to the forward portion. These phenomena are interpreted in terms of a charge-deposition model including radiation-induced conductivity. (auth)

22576 GAMMA DOSE DISTRIBUTIONS AT AND NEAR THE INFACE OF DIFFERENT MATERIALS. Wall, J. A.; Burke, E. A. (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 305-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Energy deposition profiles in aluminum and gold adjacent to materials of different atomic number were measured with a multiple-parallel-plate ionization chamber. The results show that significant variations in dose distributions occur at high photon energies where the mass energy absorption coefficients differ relatively little from one material to another. At these energies (e.g., 1.25 MeV) the perturbation in the bulk dose is no longer a simple function of atomic number alone. The enhancement or reduction in dose becomes very sensitive to the direction of the incident photon beam. The energy deposited in a material is enhanced when it is next to one of lower atomic number provided the gamma beam penetrates the lower atomic number material first. A reversal in beam direction reduces the dose to a level below what it would be for either material alone. (auth)

22577 ENHANCEMENT OF EMP SHIELDING BY FERROMAGNETIC SATURATION. Ferber, R. R.; Young, F. J. (Westinghous Electric Corp., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 354-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A limiting nonlinear theory is developed for the shielding of strong transient electromagnetic fields by ferromagnetic materials, and experimental work confirms the theory. In the experiments, tubes of Hipernom and other magnetic and nonmagnetic materials were subjected to large discharge current pulses, and attenuation was measured in wires in the interior. Pulse levels were varied up to full saturation of the tube material, and saturation diffusion times were measured and compared with theory. The results show that shielding is high in magnetic materials when the saturation does not penetrate completely, that Hipernom and other magnetic materials are ideal shielding for nuclear EMP, and that permeability and coercive force are important in calculating the attenuation only when partial saturation occurs. (D.L.C.)

22578 CHARGED PARTICLE TRACKS IN SOLIDS AND LIQUIDS. Proceedings of the Second Conference Held at Cambridge, England, 8-11 April 1969. Adams, G. E.; Bewley, D. K.; Boag, J. W. (eds.). Conference Series No. 8. London; Institute of Physics and the Physical Society (1970). 238p. 125s. (CONF-690429).

Twenty-nine papers were presented at the conference. A separate abstract was prepared for each. (UK)

For abstracts of individual papers see: 21005, 21006, 21036-21043, 21399, 21400, 21439, 21586-21589, 22579-22588, 22620, and 22621.

22579 FORMULATION OF TRACK STRUCTURE THEORY. Fano, U. (Univ. of Chicago). pp 1-7 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

A brief review is given of the early phases of track structure development. Current theory is summarized and its basic limitations are analyzed. Possible lines of development are indicated and recent fragmentary progress is outlined, particularly with regard to the connection between deflections and impact parameters in collisions along the track. (auth) (UK)

22580 TIME DEPENDENCE OF THE DIELECTRIC CONSTANT. Schiller, R. (Central Research Inst. for Physics, Budapest). pp 8-9 of Charged Particle Tracks in Solids and

Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Interionic forces and energies are greatly influenced by the dielectric constant of the substance holding the ions. The dielectric constant of dipolar substances varies with the magnitude and rate of change of the electric field; thus, one would expect the dielectric constant to depend on the density, velocity, and age of the ions distributed in the dipolar material. A simple formula, valid if the net amount of charges in the system is constant, is proposed. The expression shows the overall dielectric constant to depend only on the age of the ions. (auth) (UK)

22581 RANGE OF ELECTRONS BELOW 1 keV. Holt, P. D. (Atomic Energy Research Establishment, Harwell, Eng.). pp 42-8 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The quantum-mechanical formula for the energy loss of electrons by ionization and excitation fails at low energies (below about 200 eV) and this energy region is of critical importance for target theory. An attempt was made to calculate the stopping power using a formula based on classical principles proposed by Gryzinski. Cross sections of atoms for ionization and excitation by electron impact, calculated from related formulae, are compared with experimental data. Ranges calculated using Gryzinski's formula are compared with those proposed by Marshall et al. (1969). An examination of the discrepancies between previously proposed range–energy relationships is given. (auth) (UK)

22582 ENERGY DEPOSITION IN MICROSCOPIC VOLUMES. Glass, W. A.; Roesch, W. C.; Braby, L. A. (Pacific-Northwest, Richland, Wash.). Contract AT(45-1)-1830. pp 56-61 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The initial energy deposited by a proton is distributed radially, in a random fashion, about the proton path. One way of investigating this distribution of energy is to probe the proton track with a small cylindrical absorber (a few hundred Ångströms equivalent radius simulated by a wall-less proportional counter in rarefied gas). When the probe is traversed by monoenergetic protons along various known chords, the spectra of absorbed energies show large statistical fluctuations as predicted by straggling theories. However, the observed mean and variance of these spectra can be explained only by consideration of the energetic δ rays produced in primary interaction of the proton. Many of the δ rays have ranges greater than the dimensions of the probe. Significant energies are deposited in the probe by protons passing up to 500 Å from its edge. (auth) (UK)

22583 EFFECT OF CHEMICAL COMPOSITION AND OF INITIAL ENERGY ON THE PHYSICAL TRACK STRUCTURE FOR FAST ELECTRONS. Santar, I.; Bednar, J. (Inst. of Nuclear Research, Rez, Czech.). pp 62-76 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429

A general formulation developed earlier to interrelate the physical structure of the track of fast electrons and the concept of degradation spectra is summarized and applied to four representative light media. Extended computations of the degradation spectra are used for the discussion of extraspur structure and energy partition among track entities, and influence of the molecular nature and the initial electron energy is examined. The only major effect of the chemical nature of the irradiated medium concerns the yield and energy distributions of spurs and is illustrated by combining the present method with recent optical-approximation data. (auth) (UK)

22584 PARAMETERS OF TRACK STRUCTURE. Kellerer, A. M. (Gesellschaft fuer Strahlenforschung, Neuherberg, Ger. Columbia Univ., New York). pp 77-85 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Linear energy transfer (or collision stopping power) and energy straggling along the tracks of charged particles are both relevant to the effectiveness of ionizing radiation. Energy straggling is the dominant aspect whenever one is concerned with small energy depositions (<1 keV) and a correction to LET is necessary in these cases. The correction term and its relation to the spectrum of energy transfers in primary collisions is derived. Other parameters of track structure are discussed, and an analysis is mentioned which can substitute the Landau and Vavilov theory in the analysis of the collision spectrum. (auth) (UK)

22585 INFORMATION ABOUT THE STRUCTURE OF THE TRACK OF A HIGH-ENERGY ELECTRON IN A LIQUID AS OBTAINED FROM ELECTRIC CONDUCTANCE MEASUREMENTS. Hummel, A. (Reactor Inst., Delft, Netherlands). pp 98-104 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The spatial distribution of the charged species in the track of a fast electron in a dielectric liquid is considered. The ions will mostly be formed in groups of a few ion pairs. Most of them will recombine with ions of the same group, but some of them will escape and become homogeneously distributed throughout the liquid. The number of ion pairs that escape, which can be determined from conductance measurements, contains information about the spatial distribution of the ions in the track. The theoretical background is reviewed. Experimental methods are described and some typical results are discussed. (auth) (UK)

22586 PARTICLE TRACKS IN CONDENSED MATTER. Katz, R.; Kobetich, E. J. (Univ. of Nebraska, Lincoln). pp 109-19 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

A proposed theory of track formation attributes observed effects to the spatial deposition of energy by secondary electrons. The theory is compared to experimental observations in a variety of fields, with good results. In contrast, linear measures of the interaction of charged particles with matter (LET, primary excitation, primary ionization, restricted energy loss) are unsuitable parameters through which to describe particle tracks, except in limiting cases, because many detection media are saturable. Energy deposited close to a particle's path often produces a disproportionately small response, because of "overkill." (auth) (UK)

22587 SIMILARITY OF SECONDARY-ELECTRON TRACKS. Harder, D. (Univ., Wuerzburg, Ger.). pp 160-6 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

The scaling law of similarity rule for multiple scattering and slowing down of electrons considerably simplifies the physics of secondary electron tracks. The Lewis–Spencer transport theory shows that the directional and spectral distribution of the electron fluence behaves as a universal function if the space coordinates and the residual path length are scaled with reference to the average path length. The way the universal function changes from high to medium energy electrons is in agreement with experiments. Screening effects reducing the curvature of electron tracks disturb the scaling behavior at low energies. For very low energies, another rise of the curvature is expected. (auth) (UK)

22588 PHYSICS OF ENERGETIC PARTICLES MOVING THROUGH CONDENSED MATTER. Kistemaker, J.; Sanders, J. B. (FOM-Inst. for Atomic and Molecular Physics, Amsterdam). pp 197-207 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

Some formulae are derived and some numerical results given for the path lengths and penetration depths of projectiles in target materials. Various combinations of projectile and target species are considered. Also estimates are made of both elastic and inelastic stopping. (auth) (UK)

22589 CHARACTERISTIC ENERGY LOSS SPECTRA OF ELECTRONS IN TUNGSTEN SINGLE CRYSTALS. Korablev, V. V. (Leningrad Polytechnical Inst.). Sov. Phys.-Solid State (Engl. Transl.); 12: 1298-1300(Dec 1970).

Translated from Fiz. Tverd. Tela; 12: 1638-40(Jun 1970).

Electrical differentiation by means of a phase-sensitive detector was used in an experimental study of the spectra of electrons reflected with characteristic energy losses from tungsten single crystals. The primary electrons had various energies and

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were incident at various angles. The energy-loss peak dependences on the energy and the incidence angle of the primary electrons yield information about the nature of the characteristic energy losses, i.e., whether they are due to surface and volume plasma oscillations or interband transitions. (auth)

Solid-State Physics

Radiation Effects

Refer also to abstracts 21500, 21518–21520, 21522, 22213, 22578, 22588.

22590 (COO–125-56) BASIC RADIATION DAMAGE STUDIES. Technical Progress Report, December 15, 1969–December 15, 1970. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 30 Dec 1970. Contract AT(11-1)-125. 5p. Dep. NTIS.

The studies are being concentrated on the defects introduced into Ge and Si by electron irradiation at low temperatures, their behavior and reactions, and radiation annealing. Results reported are on radiation annealing of two acceptor centers in n-type Ge, temperature-dependent radiation annealing in n-type Si, and radiation annealing of E centers in Si. (D.L.C.)

22591 (COO–1198-781) ELECTRON IRRADIATION EFFECTS IN SILICON AT LIQUID HELIUM TEMPERATURES USING AC HOPPING CONDUCTIVITY. McKeighen, Ronald Eugene (Illinois Univ., Urbana). 1971. Contract AT(11-1)-1198. 128p. Dep. NTIS.

Thesis.

Changes in ac hopping conductivity with electron irradiation have been measured in n-type silicon, p-type silicon, and high-purity silicon. Irradiations were carried out at both 5.0 and 1.6°K, with measurements made at reference temperatures of 4.2 and 1.3°K, respectively. In the p-type crystals, the changes in ac hopping conductivity depended strongly on the concentration of chemical acceptors, indicating a concentration dependence on impurities in the defect production rate. The production rates at 1.6°K were generally very similar to those for a 5.0°K irradiation. No significant thermal-annealing stages below room temperature were observed in any of the crystals. A small amount of "reverse annealing," i.e., an increase in ac hopping conductivity was observed below 30°K. No radiation-annealing effects due to a beam of either 0.500- or 0.350-MeV electrons were observed, either at 4.5°K or at 1.45°K. (auth)

22592 (COO–1800-13) FUNDAMENTALS OF RADIATION DAMAGE. Technical Progress Report, February 1, 1970–February 1, 1971. Sosin, A. (Utah Univ., Salt Lake City). Contract AT(11-1)-1800. 15p. Dep. NTIS.

COPPER—radiation effects on internal friction and Young's modulus of, 1- to 2-MeV electron
—radiation damage rate in, effects of thermal conversion of defects on electron
—radiation effects on electric resistivity of, deviations from Matthiessen's rule at 10 to 120°K in electron
ELECTRONS—effects on copper at 1 to 2 MeV, damage in (D.L.C.)

22593 (INIS-mf-16) INFLUENCE OF COLOUR CENTERS ON DISLOCATION ETCHING IN NEUTRON IRRADIATED BaF_2. Patel, A. R.; Singh, R. P. (Department of Atomic Energy, Bombay (India). Chemistry and Metallurgy Committee). 1970. 9p. (CONF-700218–8). NTIS (U. S. Sales Only).

From Symposium on materials science research; Bangalore, India (24 Feb 1970)

Single crystals of BaF_2 were irradiated with a neutron dose of 10^{13} n/cm^2/sec for 84 hours. It was observed that the transparent crystals became colored and when they were heated the color was bleached. The absorption spectra of the irradiated colored crystals and crystals bleached by heating were obtained. It was found that the results are in conformity with those reported by Messner and Smakula. The etch patterns on the irradiated and the nonirradiated cleavages were compared. It was observed that a number of small micropits are produced on irradiated cleavages. The sites of the dislocation etch pits were not affected, but their sizes were found to be comparatively smaller than those on unirradiated cleavages. The irradiated crystals were heated at 600°C for 6 hours and then etched. The micropits decreased in number but there was no change in the number of dislocation pits. The implications are discussed. (auth)

22594 (JPRS–52565) ION BOMBARDMENT IN LATTICE DEFECTS AND SEMICONDUCTOR FABRICATION. Translation of two Russian articles. 31p. NTIS.

Separate abstracts were prepared for the two articles. (D.L.C.)

For abstracts of individual papers see: 22595 and 22596.

22595 (JPRS–52565, pp 1-15) INJECTION OF 10 TO 80 keV LITHIUM IONS INTO DIAMOND. Galkin, V. V ; Krasnopevtsev, V. V.; Milyutin, Yu. V. Translated from Fiz. Tekh. Poluprov ; 4: 837-46(1970).

Light interference was used to study defects induced in diamond by 10- to 80-keV Li ions at doses of 10^{14} to 10^{16} cm^{-2}. Two layers with different refractive indices were found to be formed, corresponding to unchannelized and channelized ions. Heat treatment leads to annealing of the defects at low doses and to formation of graphite at the higher doses. A depth distribution of total conductivity was measured and found to agree with interference measurements. (D.L.C.)

22596 (JPRS–52565, pp 16-31) ION BOMBARDMENT AS A METHOD OF FABRICATING MULTILAYER SEMICONDUCTOR DEVICES. Pavlov, P. V.; Vasil'ev, V. K.; Zorin, E. I.; Tetel'baum, I.; Tulovchikov, V. S.; Chigirinskaya, T. Yu.. Translated from Izv. Vyssh. Ucheb. Zaved. Radioelektron.; 13: 493-505 (1970).

Bombardment of Si with B and P ions at energies up to 200 keV is shown to produce reproducible distributions at depths up to 1 μ. Generalized families of B and P distributions in a broad range of dose strengths and energies are presented for the fabrication of multilayer structures. The fabrication of uhf transistors by successive irradiations with B and P ions and of planar p–n–p transistors by ion bombardment and diffusion are discussed as examples. (D.L.C.)

22597 (N–70-43095) INVESTIGATION OF THE STRUCTURE OF RADIATION DAMAGE IN LITHIUM-DIFFUSED SILICON. Midway Progress Report, January 1–June 1, 1970. Corelli, John C. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). Contracts NAS7-100; JPL-952456. 26p. (NASA-CR–110890). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

A brief description is given of instrumentation and methods used in the study of radiation damage in lithium-diffused silicon in which infrared photoconductivity and infrared spectroscopy are used as the probes. The defects were induced in the material by 1.5-MeV electrons at 300°K. Also included is a detailed description of the cryostat to be used in cold-temperature electron irradiations that permits both electrons of <3 MeV and light of 1 to 15 microns to irradiate the sample. (auth) (STAR)

22598 (N–71-10380) OPTICAL ABSORPTION IN TRANSPARENT MATERIALS DURING 1.5-MeV ELECTRON IRRADIATION. Palma, Gary E.; Gagosz, Ronald M. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Oct 1970. Contract SNPC-70. 76p. (NASA-CR–110907; J–990929-1). NTIS.

A program of in situ optical experiments was conducted to determine the level of radiation-induced optical absorption that exists in Corning Grade 7940 fused silica and single-crystal aluminum oxide during steady-state 1.5-MeV electron irradiation. The optical transmission of a total of 25 fused silica specimens was measured during electron irradiation over a range of ionizing dose rates (0.02 to 10 Mrads/sec) and specimen temperatures (40 to 900°C). Three of these specimens were previously reactor-irradiated to a dose of 10^{17} fast n/cm^2. In addition to measuring the transmission at the peak of the strong radiation-induced absorption band centered at 2150 Å, spectral scans over the wavelength interval 2050 to 2500 Å were also made. The decay of the radiation-induced absorption due to optical bleaching and the rate of recoloration following optical bleaching were measured in order to determine the effectiveness of optical bleaching and to obtain information relating to the damage mechanism responsible for the radiation-induced absorption. The most surprising and important result was the low level of radiation-induced optical absorption at dose rates equal to those expected in a nuclear-light-bulb engine, which is believed to be due to radiation annealing. (auth) (STAR)

22599 (N–71-11888) ELECTRON PARAMAGNETIC RESONANCE STUDY OF Cr^{+3} IN X-RAY IRRADIATED RUBY. Liu, David C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov 1970. 11p. (NASA-TN-D–6079; E–5531). NTIS.

By EPR technique, dynamic measurements were made of the increase of Cr(+3) concentration in the x irradiated ruby crystals during isothermal annealings. The thermal recovery of chromium

ions to the +3 state was found to be a first-order process. The activation energy of this process was found to be 1.37 ± 0.07 eV. The method described should be generally applicable to the study of decays involving paramagnetic centers. (auth) (STAR)

22600 (RISO–236) NUCLEATION OF DAMAGE CENTRES DURING ION IMPLANTATION OF SILICON. Chadderton, Lewis T. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sep 1970. 25p. Dep. NTIS (U. S. Sales Only).

Nucleation of damage centers in single–crystal silicon held at room temperature and bombarded in a random direction with light ions is not at all times heterogeneous, as has sometimes been assumed. Homogeneous nucleation of interstitial clusters occurs at low ion fluences and this is characterized, for an extremely short period, by a linear dependence of the state of disorder on ion fluence, followed by a longer period during which disorder $\propto$ (fluence)$^{\frac{1}{2}}$. During these periods of "nucleation" and "primary growth," small interstitial clusters behave as unsaturable traps. For higher fluences there is a smooth transfer to a form of heterogeneous nucleation, which is not of displacement cascade origin. In this period of "secondary growth," the state of disorder varies linearly with ion fluence, and interstitial clusters behave as nucleation traps. It is shown how marked effects on the state of disorder due to changes in the mass of the bombarding ion, in the flux of the impinging beam, or in the temperature and impurity content of the bombarded crystal can be simply traced to an assistance for or a resistance to the onset of heterogeneous over homogeneous nucleation. (auth)

22601 IRRADIATION DAMAGE BY BETA PARTICLES. Coltman, R. R. Jr. (Oak Ridge National Lab., Tenn.); Klabunde, C. E.; Weber, W. J. Rev. Sci. Instrum.; 42: 279-80(Feb 1971).

Gold foil was rolled into a cylinder, an anodized Al wire was inserted into the cylinder, and leads were soldered to both Au and Al for residual resistance measurements. The assembly was irradiated to a thermal neutron dose of 5.3×10^{18} n/cm^2. After 24-hour cooling, the irradiated assembly was placed in a liquid-He vessel and increases in the residual resistance measured for 141 hr. The gold increase was attributed to mercury transmutation and the Al change to irradiation damage by the beta particles from Au. Both resistivity increases with time proceeded in exponential decay fashion, which agreed with the half-life of gold. (D.L.C.)

22602 TEMPERATURE AND ENERGY DEPENDENCE OF PROTON DECHANNELING IN SILICON. Foti, G.; Grasso, F.; Quattrocchi, R.; Rimini, E. (Univ., Catania, Italy). Phys. Rev., B; 3: 2169-79(1 Apr 1971).

The dechanneled fractions of protons impinging along the ⟨111⟩ and ⟨110⟩ axial directions of Si were measured for ion energies between 0.3 and 1.5 MeV and for target temperatures ranging between 80 and 423°K. The dechanneled fraction is a linear function of the penetration depth z. Its dependence on beam energy E and the target temperature T can be described simply through the parameter $z\rho^2/E$, ρ^2 being the mean-square vibrational amplitude normal to the row. All the experimental points follow a unique linear trend if plotted vs $z\rho^2/E$. The dechanneled fraction for the ⟨110⟩ axis is a factor of 2 lower than that for the ⟨111⟩. A theoretical model was developed to describe the dechanneling in terms of a steady increase in the transverse energy, accounting for both electronic and nuclear reduced multiple scattering. The initial transverse-energy distribution of the particle just beneath the crystal surface has been computed including the experimental angular spread, and both scatterings produced by the amorphous layers covering the surface and by the atomic string potential. The limiting transverse energy for the channeled-to-random transition has been taken from the experimental $\psi_1(T)$ values. The computed dechanneled fractions agree reasonably well with the experimental ones and justify their temperature and energy dependence. The calculated fractions differ from the experimental ones in their having an upward curvature; the significance of this disagreement is briefly discussed together with the approximations involved. (auth)

22603 SPUTTERING OF ZrO_2 GROWN IN VARIOUS WAYS. Benfenati, Luigi; Ostoja, Paolo; De Maria, Enrichetta Susi (Univ., Bologna). Ric. Sci.; 39: 395-9(Apr-Jun 1969). (In Italian).

The sputtering of ZrO_2 films thermally and anodically prepared on Zr crystal bars and Zircaloy-2 under bombardment by Ar ions was investigated. The sputtering time was measured as a function of the oxide thickness. The graphed results show a deviation from the expected linearity. It is suggested that this deviation is caused by the transition of the oxide from the cubic to the monoclinic structure. (J.S.R.)

22604 TEMPERATURE DEPENDENCE OF DEFECT PRODUCTION IN KBr AND KCl. II. Comins, J. D. (Univ. of the Witwatersrand, Johannesburg). Phys. Status Solidi (b); 43: 113-20(1 Jan 1971).

Studies of the growth of F centers in Harshaw KBr and KCl during x irradiation as a function of temperature show that the "late-stage" production rate progressively decreases as the temperature of irradiation T is increased above ≈195°K for KBr and above ≈213°K for KCl. Various mechanisms are examined to explain this effect. The results are found to be in semiquantitative agreement with the predictions of the excitonic mechanism of defect production, but arguments are presented to show that the mechanism of suppression involving mobile vacancies makes some contribution. The V bands formed in the range investigated (195°K < T < 298°K) show a continuing progressive change in shape and peak position with increasing temperature of irradiation. Their growth behavior becomes increasingly nonproportional to F-center growth as T increases, but nevertheless, the overall "late-stage" rate decreases in a manner comparable with that found for F centers and provides evidence that they are of an interstitial nature. The growth of the 213-nm band shows a two-stage behavior; the first results from decomposition of OH^- centers to form the U band, and the later stage is considered to be due to the formation of V_3 centers. (auth)

22605 OPTICAL SPECTRA OF M, F_3^+-SINGLET, AND F_3^+-TRIPLET CENTERS IN NaF. Elsaesser, K.; Seidel, H. (Univ., Stuttgart). Phys. Status Solidi (b); 43: 301-5(1 Jan 1971).

X-irradiated NaF crystals contain, after bleaching, the F band, mainly M and F_3^+ centers. Complete orientation of the M centers and partial orientation of the F_3^+ centers can be achieved. The F_3^+ centers, identified by their 546.6-nm zero-phonon line, have broad absorption bands at 512 and 303 nm. Upon strong excitation in the region of the 303-nm band, a temporary bleaching of both the bands and the zero-phonon line is found and ascribed to population of a metastable F_3^+-center triplet state with a lifetime of τ = 1.9sec at 77°K. (auth)

22606 BEHAVIOR OF PRIMARY DEFECTS IN ELECTRON-IRRADIATED GERMANIUM. Bourgoin, J.; Mollot, F. (Ecole Normale Superieure, Paris). Phys. Status Solidi (b); 43: 343-55(1 Jan 1971).

An investigation is made of the influence of the free electron and donor impurity concentrations on the annealing kinetics of the 35 and 65°K stages and on the creation rate of the 35°K stage, in low-temperature electron-irradiated n-type germanium, using As- or Sb-doped samples, Ga- and Cu-compensated samples, and a Li-doped sample. The results show that mobility of the Ge interstitial occurs at 4.5, 27, and 65°K, depending on its charge state and mobility of the vacancy at 90°K. The defect associated with the 35°K stage is identified as a vacancy–interstitial pair where the interstitial is a donor impurity (annealing through the interstitial mobility). This interstitial mobility, strongly dependent on the charge state, explains radiation annealing and the behavior of irradiated p-type germanium. (auth)

22607 IDENTIFICATION OF THREE TRAPPING CENTERS IN CALCIUM TUNGSTATE. Koehler, H. A. (Univ. of California, Livermore); Kikuchi, C. Phys. Status Solidi (b); 43: 423-32 (1 Jan 1971).

Partial thermal annealing of nominally pure calcium tungstate, after gamma irradiation at 78°K, provided evidence for identifying three major 4900-Å thermoluminescence peaks at 0.36, 0.55, and 0.72 eV with three groups of electron spin resonance lines of paramagnetic tungsten at g_{001} = 2.009 and 1.843 and niobium at g_{001} = 2.021, respectively. The impurity center identified with the paramagnetic Nb^{+4} ion is assigned to a tungsten site and a NbO_4^{-4} complex. Arguments are presented for the assignment of two lattice defect models, a WO_4^{-3} complex with nearby WO_3 and NbO_5^{-3} complexes, and a WO_3^{-1} complex with a nearby calcium deficiency, to the paramagnetic $(W^{+5})_A$ and $(W^{+5})_B$ ions, respectively. (auth)

22608 COLOR CENTERS IN IRRADIATED POTASSIUM MAGNESIUM FLUORIDE AND POTASSIUM MANGANESE FLUORIDE. Riley, Claude Roger Jr. Knoxville, Tenn.; Univ. of Tennessee (1970). 131p. University Microfilms Order No. 71-365. Thesis.

F centers are observed in irradiated $KMgF_3$ and give rise to an optical absorption band at 280 nm. F-center production by 2.0-MeV electron irradiation for temperatures between 7 and 300°K has been investigated. At high temperatures the suppression of the coloration caused by electron-trapping impurities is compared with that expected for two possible annihilation mechanisms depending respectively on a reduced formation rate for F centers and an enhanced destruction rate of F centers. The experiments

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favor the latter possibility. Cluster centers are also formed by irradiation, and polarized bleaching experiments on irradiated $KMgF_3$ crystals show that F_2 centers absorb light at 445 and 282 nm, F_3 centers at 395 nm and about 250 nm, and V_K centers at 340 nm. The temperature dependence of the full width at half maximum of the F- and F_2-absorption bands has been studied. An analysis of the F_2-center absorption band data, assuming a linear coupling model, indicates the emission from this center should occur at 534 nm. This is close to an observed 590-nm emission band that has been attributed to this center. An emission band at 465 nm has been attributed to F_3-center emission. The polarized emission studies presented here agree with these assignments. Emission bands at 407 and 600 nm are most likely due to F-center and Mn^{2+} impurity emission, respectively. Irradiated crystals of $KMnF_3$ show a radiation-induced absorption band at 310 nm. Using a Mollwo–Ivey relationship, this scales roughly with the F center observed in $KMgF_3$. An immediate saturation of the coloration is observed at all temperatures in $KMnF_3$. It is proposed that the presence of an impurity is necessary for the Pooley mechanism to be operative in $KMnF_3$ and that the coloration at saturation is related to the concentration of some impurity or impurities in the crystal. Crystals of $KMgF_3$: Mn show several absorption bands that may be due to F_A, F_B, or M_A type centers. (Diss. Abstr. Int., B)

22609 EFFECTS OF METASTABLE CHARGE STATES ON SHORT-TERM ANNEALING IN p-TYPE SILICON. Curtis, O. L. Jr. (Northrop Corporate Labs., Hawthorne, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 105-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

In contrast to n-type material, short-term annealing of neutron-induced lifetime damage in p-type silicon is strongly dependent upon minority carrier density. While physical reordering is an important process, and may be somewhat dependent upon excess electron density in p-type material, arguments presented indicate that this difference between n- and p-type material is primarily an electronic effect having to do with neutralization of metastable charge states induced during defect production. A qualitative model is presented that appears to be more consistent with experimental observations than those which depend upon physical defect motion alone. (auth)

22610 MODEL FOR SHORT-TERM ANNEALING OF NEUTRON DAMAGE IN p-TYPE SILICON. Leadon, R. E. (Gulf Radiation Tech., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 110-17(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

A model is presented for the short-term annealing of a damage cluster resulting from neutron radiation in p-type silicon. The damage cluster is assumed to be a disordered core imbedded in an otherwise undisturbed lattice, as suggested by Gossick. The disordered core is characterized in this model by two defects. The dominant defect immediately after the damaging event is assumed to be the vacancy, which is represented by a two-level defect (donor–acceptor) in the forbidden gap. The density of this defect decreases with time as a function of the densities of its different charge states. The second defect is the divacancy which is also represented by a two-level defect in the forbidden gap. The density of the divacancies increases as the vacancies anneal. The analysis is made for a single, spherically symmetric cluster located at the center of a sphere of radius R of undamaged material. The problem is solved by the PN code which approximates the exact continuity, Poisson's, and generation-recombination equations in finite difference form. Annealing factors are obtained as a function of time by simulating a steady, uniform ionization rate throughout the sphere R. An effective lifetime for the volume R is calculated as the instantaneous average density of excess minority carriers in the sphere divided by the ionization rate. Time histories of the annealing factors are compared to experimental data obtained from short-circuited solar cells. (auth)

22611 SHORT-TERM ANNEALING IN ELECTRON-IRRADIATED p-TYPE SILICON. Srour, J. R. (Northrop Corporate Labs., Hawthorne, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 118-22(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Studies of short-term annealing of minority carrier lifetime in bulk p-type silicon following ~1.4-MeV pulsed-electron irradiation are reported. Investigations were performed on vacuum-float-zone boron-doped material in the temperature range 235 to 386°K and the maximum fluence employed was $\sim 5 \times 10^{12}$ electrons/cm^2. Simple exponential recovery under isothermal conditions, a characteristic of first-order reaction kinetics, was observed. The amount of unstable damage varied as exp $(-t/\tau_R)$, where τ_R is the characteristic recovery time. The temperature dependence of τ_R yielded an activation energy of 0.32 ± 0.03 eV for the recovery process. The current results, when extrapolated to lower temperatures, compare quite closely with Watkins' EPR data for similar material. It is concluded that the present data are consistent with the observation of neutral vacancy annealing. (auth)

22612 SHORT-TERM ANNEAL OF 30-MeV ELECTRON DAMAGE IN HIGH-PURITY n-TYPE SILICON. Mallon, C. E.; Naber, J. A. (Gulf Radiation Tech., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 123-7(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Minority-carrier lifetime and electrical conductivity measurements were used to observe short-term anneal of the primary electrically active defects produced in high-resistivity n-type silicon by 4.5-μsec 30-MeV electron pulses. These parameters were monitored from approximately 10 msec to 10 minutes following the electron pulse. Conductivity anneal experiments were conducted over a temperature range of 200 to 340°K, and lifetime experiments from 273 to 340°K. A transient forward anneal (recovery) of minority-carrier lifetime was observed for n-type silicon over this temperature range. This material exhibited a reverse (damage growth) conductivity anneal following a 30-MeV electron pulse. The growth in carrier removal sites with time is attributed to the diffusion of isolated vacancies to form the vacancy–phosphorus complex. The dependence of the anneal time constant and initial carrier removal rate on the Fermi level position suggests that the $(\frac{-}{0})$ level of the isolated vacancy is above the center of the forbidden gap at approximately 0.39 eV below the conduction band edge. (auth)

22613 STUDY OF THE DIVACANCY IN IRRADIATED SILICON USING INFRARED SPECTROSCOPY AND INFRARED PHOTOCONDUCTIVITY MEASUREMENTS. Corelli, J. C.; Young, R. C.; Chen, C. S. (Rensselaer Polytechnic Inst., Troy, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 128-36(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The annealing behavior and the uniaxial stress response of radiation-induced defects in Si causing the 1.8-, 3.3-, and 3.9-μ infrared absorption bands, and the $E_c - 0.39$ and $E_c - 0.54$ eV photoconductivity levels were studied after 1.5- and 45-MeV electron and fast-neutron irradiation. In addition, photoconductivity associated with the 0.32-eV (3.9-μ) band is reported. Correlating all of the above results with those obtained previously in electron paramagnetic resonance (EPR) studies leads to the conclusion that the defect responsible is the divacancy, i.e., one in which two adjacent Si atoms are knocked out of the lattice to form the intrinsic divacancy defect. The predictions of the divacancy model of Watkins and Corbett are found to give good agreement with the experimental results, in particular as the results are correlated on a microscopic scale with EPR measurements. (auth)

22614 CARRIER REMOVAL IN NEUTRON IRRADIATED SILICON. Holmes, Robert R. (Bell Telephone Labs. Inc., Whippany, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 137-43(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

It is demonstrated that a spherical defect cluster is not adequate to explain the doping dependence of carrier removal in neutron-damaged silicon. To resolve this problem, a cylindrical cluster of the type calculated by Van Lint et al. is examined. This type of cluster can be described as a "supercluster" composed of several subclusters of extremely high defect concentration (10^{21} cm^{-3}) embedded in a tree of defects of lower concentration (10^{18} cm^{-3}). The subclusters arise from the final stopping of the recoil atoms. Subclusters are less than 60 Å in diameter and contain up to 100 individual defects. The tree of defects arises from displacements occurring along the tracks of the recoiling lattice atoms. From a consideration of the distribution of space charge and electric potential associated with this type of structure, quantitative predictions are made of the doping dependence of carrier removal. These predictions depend on the cluster dimensions and the Fermi energy within the cluster. Since the cluster dimensions can be obtained from the work of Van Lint et al., the predictions depend on only one undetermined parameter. Excellent fit is obtained between this theory and published data on carrier removal. The indicated values of the Fermi energy within the cluster are 0.48,

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0.38, 0.51 eV for n-type float-zone, n-type Czochralski, and p-type silicon, respectively. These values are not inconsistent with an assignment based on known energy levels of the divacancy and the A center. (auth)

22615 ANNEALING OF ELECTRON BOMBARDMENT DAMAGE IN LITHIUM-CONTAINING SILICON. Brucker, George J. (RCA Astro-Electronics Div., Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 144-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

The results of these measurements are applicable to the design of lithium-containing solar cells. Data concerning the speed and stability of recovery from irradiation damage are presented, including the dependence of these parameters on the lithium and oxygen concentration of the silicon. Float-zone-refined silicon doped with lithium to a concentration $\leq 5 \times 10^{14}$ cm^{-3} exhibits post-irradiation damage properties similar to those measured on quartz-crucible silicon doped with lithium from 10^{15} to 10^{16} cm^{-3}. The speed of recovery from damage (e.g., the mobility) is several hundred times faster in oxygen-lean float-zone-refined silicon than in oxygen-rich quartz-crucible-grown silicon. Two mechanisms of annealing, namely by neutralization and by dissociation of carrier-removal centers, were observed in these experiments. Both mechanisms of annealing take place in float-zone silicon doped with lithium from 4×10^{15} to 10^{16} cm^{-3}, but only the mechanism of neutralization is observed in samples of float-zone silicon doped with lithium concentrations $\leq 5 \times 10^{14}$ cm^{-3}. In contrast to this behavior, only the mechanism of neutralization is observed in quartz-crucible silicon doped with lithium from 10^{15} to 10^{16} cm^{-3}. A continuous decrease in carrier density is observed to occur for periods ranging from five months to 18 months in irradiated-float-zone silicon with lithium concentrations $\leq 5 \times 10^{14}$ cm^{-3}, and in quartz-crucible silicon with lithium concentrations from 10^{15} to 10^{16} cm^{-3}, respectively. This mechanism produces uncharged complexes of lithium. A defect located at an energy of $\approx E_c - 0.12$ eV was measured in irradiated-float-zone silicon doped with lithium concentration $\leq 5 \times 10^{14}$ cm^{-3}. (auth)

22616 ION IMPLANTATION DAMAGE EFFECTS IN SILICON. Eberle, David E. (Langley Research Center, Hampton, Va.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 150-3(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Optical reflectivity measurements were made on crystalline Si implanted with 60-keV In, Zn, P, and Be ions to doses of up to 3×10^{16} ions/cm^2. The measurements covered the 4- to 6-eV range, and amorphous layer formation was determined as a function of ion mass and dose. The temperature required to anneal the optically effective damage was determined. (D.L.C.)

22617 RADIATION-INDUCED LOW ENERGY ELECTRON EMISSION FROM METALS. Burke, E. A.; Wall, J. A.; Frederickson, A. R. (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 193-9(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Low-energy electron emission from several metals exposed to ^{60}Co gamma rays, 10-MeV electrons, and 0.1- to 1.0-keV electrons has been studied. The experiments described here, together with other reported results, indicate that for a given metal the emission of electrons with energies below 50 eV is proportional to the absorbed dose and is independent of the type and energy of the primary radiation. For the common metals the charge emitted per square centimeter per rad is found to be between 1.0 to 3.0×10^{-13} coulombs. It also appears that the magnitude of the emission induced by high-energy radiations can be predicted from the secondary emission yields observed under low-energy electron bombardment. Under certain assumptions it is shown that the data is consistent with an internal isotropic low-energy electron distribution given by $N(E) \propto E^{-3}$. (auth)

22618 RANGE OF SECONDARY ELECTRONS IN SAPPHIRE. Harrity, John W. (Gulf Radiation Tech., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 200-4(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

During irradiation tests on a Czochralski-grown single-crystal sapphire sample, a trapping phenomenon was observed that led to an apparent nonlinear dependence of the radiation-induced conductivity on dose rate. These data are interpreted in terms of a minimum projected range of the secondary electrons generated by the primary beam. A range of about 1000 Å is calculated. (auth)

22619 MONTE CARLO ANALYSIS OF GAMMA SCATTERING IN SILICON AND GERMANIUM. McLain, M. E. Jr.; Walker, D. M.; Carr, H. E. (Georgia Inst. of Tech., Atlanta). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 301-4(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Calculations were made of the number and energy spectra of primary electrons generated in silicon and germanium volumes by incident gamma photons of energy 300 keV to 3 MeV. Direct calculations were used for small silicon samples, and Monte Carlo methods for larger germanium samples where multiple gamma scattering was significant. Primary electron populations generated within silicon by the same exposure dose from cesium-137, cobalt-60, sodium-24 and fission gamma sources are compared. The simulation of primary electron spectra generated within the sample, rather than the incident gamma spectrum, is considered as an applied radiation effects technique. The multiple scattering calculations show that as sample volume increases, the density of ionization increases for a fixed gamma exposure, and that the flux of electrons with sufficient energy to cause displacements decreases for a fixed absorbed gamma energy dose. (auth)

22620 CHARGED-PARTICLE TRACKS IN CRYSTALLINE SOLIDS. Margan, D. V. (Atomic Energy Research Establishment, Harwell, Eng.). pp 167-73 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

When energetic charged particles pass through some crystalline solids, a permanent trail of damage delineates their path. Two problems are considered; first, the track-storing property of a crystal is related to its electrical conductivity, and, second, the intermittent nature of tracks observed in MoS_2 is related to changes in the energy loss of the charged particles. (auth) (UK)

22621 AGGREGATION OF F CENTRES IN LiF. Van Den Bosch, A. (SCK-CEN, Mol, Belg.). pp 208-9 of Charged Particle Tracks in Solids and Liquids. /Adams, G. E. (ed.). London; Inst. of Physics and the Physical Society (1970).

From 2nd L. H. Gray Conference, Cambridge, England. See CONF-690429.

In single crystals of lithium fluoride irradiated at room temperature, the radiation-damage phenomena can be understood on the basis of a model in which it is assumed that primary defects are created during irradiation. The formation of aggregates of F centers, which are considered as primary defects, depends on the linear energy transfer (LET) of the radiation to the material. It is shown that the high probability for locating an F center adjacent to another one cannot be directly related to the high probability for energy deposition in tracks. (auth) (UK)

22622 THERMOLUMINESCENCE STUDY OF THE NATURAL RADIATION DAMAGE IN ZIRCON. Vaz, J. Eduardo (George Washington Univ., Washington, D. C.); Senftle, Frank E. J. Geophys. Res.; 76: 2038-50(10 Mar 1971).

The effects of natural radiation damage on gamma-ray-induced thermoluminescence (TL) in gem-quality zircons from Ceylon were examined before and after annealing at 950°C for 20 hours in a nitrogen atmosphere. Natural radiation damage is shown to reduce the TL output by a factor of 10^5, whereas annealing restores the TL. The restoration is α-dose-dependent, and can be accounted for by the breakdown of the crystal structure by α-recoil damage and recovery of the crystallinity after annealing. The data are used to develop a qualitative model of the process of α-recoil damage based on that suggested by Pellas (1965). (auth)

22623 INFLUENCE OF IRRADIATION ON THE PRINCIPAL CHARACTERISTICS OF A GALLIUM ARSENIDE LASER EXCITED WITH AN ELECTRON BEAM. Bogdankevich, O. V.; Vavilov, V. S.; Danilychev, V. A.; Kalendin, V. V.; Kryukova, I. V. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Semicond. (Engl. Transl.); 4: 1027-32(Dec 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 1209-15(Jun 1970).

An investigation was made of the influence, on the principal characteristics of a GaAs laser, of the damage caused by room-temperature excitation with 250- to 800-keV electrons. Undoped GaAs crystals, as well as crystals doped with tellurium and zinc, were used in this investigation. The highest power of the output radiation was 30 kW at 300°K for E = 800 keV and j = 25 A/cm^2 (E_0 is the energy of the incident electrons and j is the electron beam density). Prolonged excitation with high-energy electrons reduced the coherent radiation power. The rate of this reduction of the output power depended on the electron energy, radiation dose, and the doping level of the gallium arsenide. The output power was

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halved after 5×10^4 pulses of 700- to 800-keV electrons (each pulse lasted 250 nsec). The "permissible number" of pulses could be increased considerably by reducing the pulse duration to a few nanoseconds and by increasing the electron-beam density to a value many times higher than the laser threshold. (auth)

22624 FEATURES OF THE PHOTOCONDUCTIVITY SPECTRA OF p-TYPE Si IRRADIATED WITH FAST ELECTRONS. Akimchenko, I. P.; Vavilov, V. S.; Plotnikov, A. F. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Semicond. (Engl. Transl.); 4: 873-5(Dec 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 1020-3(Jun 1970).

The photoconductivity spectra of electron-irradiated crystals of p-type oxygen-doped silicon were investigated at 4.2, 100, and 300°K. It was found that a minimum at $\lambda = 1.26\ \mu$, observed at 100°K in the case of high incident-light intensities, was associated with the optical charge exchange between the centers with levels at $E_v + 0.16$ eV and $E_v + 0.29$ eV. The observed charge-exchange effect could be used in a television-type infrared image converter. (auth)

22625 INVESTIGATION OF γ-RADIATION DEFECTS IN HIGH-PURITY GERMANIUM. Vitovskii, N. A.; Maksimov, M.; Mashovets, T. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 4: 880-6(Dec 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 1030-8(Jun 1970).

The process of the formation and annealing of γ-radiation defects in pure germanium was investigated. It was found that the principal process in n-type germanium was the combination of vacancies with atoms of group V elements. After the conversion of the germanium to p-type conduction, when all the group V atoms were bound, an increase was observed in the efficiency of the combination of the vacancies into divacancies, and of the binding of the vacancies to atoms of other impurities. (auth)

22626 IRRADIATION OF SYNTHETIC DIAMONDS WITH FAST ELECTRONS. Gerasimenko, N. N.; Lezheiko, L. V.; Litvin, Yu. A.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Semicond. (Engl. Transl.); 4: 905-8(Dec 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 1064-8(Jun 1970).

An investigation was made of the influence of irradiation with 3.5-MeV electrons and of heat treatment on the electrical and optical properties (temperature dependence of electrical conductivity and cathodoluminescence spectra) of synthetic diamonds. The irradiation and heat treatment (800°C) altered the luminescence spectra of synthetic diamonds doped with various elements in the 3000- to 10,000-Å range. Irrespective of the nature of the dopant, the spectra which were originally different in various details became similar to the luminescence spectra of irradiated and annealed natural diamonds. The resistivity of semiconducting crystals was increased by irradiation to various degrees depending on the amount of the dopant present (the increase was greater for crystals containing fewer dopant impurities). It was found that annealing at 800°C after irradiation enhanced those changes in the luminescence spectra which were due to irradiation but such heat treatment reduced appreciably the radiation-induced changes in the resistivity. It was concluded that the changes in the luminescence, observed after irradiation with fast electrons, were due to the formation of stable complexes, in which nitrogen atoms took part, and that the changes in the resistivity were due to the generation of simple defects or of unstable complexes. (auth)

22627 DISTRIBUTION OF THE CONDUCTIVITY WITH DEPTH IN DIAMOND DOPED BY BOMBARDMENT WITH 10- TO 45-keV ^{7}Li IONS. Vavilov, V. S.; Galkin, V. V.; Krasnopevtsev, V. V.; Milyutin, Yu. V. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Semicond. (Engl. Transl.); 4: 1000-2(Dec 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 1180-2(Jun 1970).

Implantations of Li ions in diamonds were carried out at 10 to 45 keV and doses of 0.6 to 6×10^{15} ions/cm^2, and the total conductivity profile was measured by etching away the crystal. The measured conductivity profile is in satisfactory agreement with that calculated by the theory of Lindhard et al. for an amorphous target, with the discrepancies being attributed to ionization losses and channeled ions. A plot of thickness for a tenfold decrease of conductivity vs ion energy is also in agreement with theory. (D.L.C.)

22628 INFLUENCE OF NEUTRON IRRADIATION ON THE REFLECTION COEFFICIENT OF GALLIUM ARSENIDE. Baramidze, N. V.; Kurdiani, N. I. Sov. Phys.-Semicond. (Engl. Transl.); 4: 1014-15(Dec 1970).

Translated from Fiz. Tekh. Poluprov.; 4: 1194-5(Jun 1970).

Pure p-type GaAs and compensated, high-resistivity GaAs were irradiated with fast neutron doses up to 2.4×10^{18} n/cm^2. The reflection peaks of the irradiated samples were found to be at 2.94, 3.16, and 5.05 eV for both p-type and high-resistivity GaAs, indicating that the irradiation shifted the reflection spectrum by 0.03 ± 0.005 eV toward lower energies for all doses. The parallel shift indicates that the forbidden band is reduced by the same amount along the [111] and [100] directions. Annealing restores the original spectrum. The band narrowing is probably due to radiation defects rather than to impurity defects. (D.L.C.)

Physical Properties

Refer also to abstracts 22008, 22047, 22066, 22091, 22093, 22103, 22104, 22108, 22159, 22185, 22193, 22205, and 22954.

22629 (COO-1629-24) THERMAL MEASUREMENTS ON SOLIDS BELOW 1 K. Progress Report No. 5. Weinstock, Harold (Illinois Inst. of Tech., Chicago. Dept. of Physics). Feb 1971. Contract AT(11-1)-1629. 21p. Dep. NTIS.

ALKALI METAL HALIDES — U-H center interaction at 4.2 to 77°K in doped, uv-ir spectral study of
GRAPHITE — thermal conductivity at 0.36 to 4.2°K of pyrolytic, effects of magnetic field on
MAGNESIUM OXIDES — radiation effects on low-temperature thermal conductivity of single crystals of, fast-neutron
NEUTRONS, FAST — effects on thermal conductivity of magnesia single crystals at low temperatures (D.L.C.)

22630 (NP-18718) TABLES OF MAGNETIC STRUCTURES DETERMINED BY NEUTRON DIFFRACTION. PART I. CUBIC SYSTEM. Oles, A.; Bombik, A.; Kucab, M.; Sikora, W. (Institute of Nuclear Techniques, Krakow (Poland)). Aug 1970. 75p. (INT-1). Dep. NTIS (U. S. Sales Only).

The tables contain: the chemical symbols of a substance; space group; cation distribution; temperatures of crystal distortions; information on crystal ordering for alloys; temperatures of magnetic transitions; brief descriptions of magnetic structure including figures, magnetic moments of atoms, and effective magnetic moments; and additional references on magnetic investigations. For some magnetic structures, magnetic space groups have been indicated. Part I contains the metals and compounds crystallizing in the cubic system. References to the original papers are included. (auth)

22631 (ORO-4049-1) RADIATION DAMAGE IN OPTICALLY TRANSPARENT MATERIALS (ZIRCONS). Progress Report. Thorpe, Arthur N. (Howard Univ., Washington, D. C. Dept. of Physics). Feb 1971. Contract AT(40-1)-4049-001. 46p. Dep. NTIS.

Ir spectral measurements were made on α-recoil-damaged natural zircons from Ceylon, and a preprint manuscript is appended. The results, obtained for both powders and thin plates, confirm the macroscopic model of Pellas. Characteristics of the powder and thin-plate spectra and annealing effects are listed. Other studies in progress include thermal analysis, shock experiments, electron microscopy, thermoluminescence, and iron content. (D.L.C.)

22632 (RISO-M-1300) PHYSICS DEPARTMENT SEMI-ANNUAL REPORT FOR THE PERIOD JANUARY 1 - JUNE 30, 1970. Moeller, H. Bjerrum; Christensen, C. J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1970. 18p. Dep. NTIS (U. S. Sales Only).

The research work of the department covers the following main fields: Neutron physics (solid-state investigations), plasma physics, nuclear spectroscopy, radiation damage, and meteorology. The main activities are described. (auth) (Denmark)

22633 PHYSICAL PROPERTIES OF SmB_6. Nickerson, J. C. (Stanford Univ., Calif.); White, R. M.; Lee, K. N.; (and others). Phys. Rev., B; 3: 2030-42(15 Mar 1971).

A model for the electronic structure of SmB_6 is proposed, suggested by new transport measurements in combination with analyses of the magnetic susceptibility and lattice energetics. The model successfully describes the resistivity, Hall effect, magnetic susceptibility, and Moessbauer isomer shift in this material. In addition, it predicts an anomaly in the low-temperature specific heat. Analysis of the lattice energetics shows that the rigidity of the boron lattice is responsible for the fact that Sm ions on equivalent sites can occur with the 4f shell in either the $4f^5$ or the $4f^6$ configuration. A relationship among the compressibilities of the rare-earth hexaborides is predicted on the basis of this analysis. (auth)

22634 FERMI SURFACES OF THORIUM AND ACTINIUM. Gupta, R. P. (Iowa State Univ., Ames); Loucks, T. L. Phys. Rev., B; 3: 1834-42(15 Mar 1971).

The results of a theoretical study of the energy bands and the Fermi surface of thorium calculated by the relativistic-augmented-plane-wave (RAPW) method and of actinium (rigid-band approximation) are reported. A muffin-tin version of the crystal potential was used and the exchange was included in the full $\rho^{1/3}$ Slater approximation. A set of 36 reciprocal-lattice vectors was used in the expansion of the wave function, and with this set the energy eigenvalues were converged to within 0.003 Ry at the points of high symmetry. The calculated bands were interpolated by the method of "spline-fits" to obtain the density of states and the Fermi energy. The Fermi surface consists of three distinct pieces: a hole surface shaped like a rounded cube centered at Γ, electron surfaces shaped like pairs of lungs centered on the symmetry lines ΓK, and hole surfaces shaped like dumbbells centered on the symmetry lines ΓL. The de Haas–van Alphen frequencies are determined and the results compared with the existing experimental data. Assuming a rigid-band model, the present results are used to predict the Fermi surface of actinium. (auth)

22635 CALORIMETRIC DETERMINATION OF THE DENSITY OF ELECTRONIC STATES IN α-PHASE INDIUM ALLOYS. I. ALLOYS WITH TIN. Lambert, Marcel H.; Brock, J. C. F.; Phillips, Norman E. (Univ. of California, Berkeley). Phys. Rev., B; 3: 1816-25(15 Mar 1971).

The low-temperature heat capacity of each of a series of indium–tin alloys containing 0 to 13 at.% tin was measured, and the density of electronic states $N(E_F)$ and the Debye temperature Θ_0 evaluated. The electron–phonon coupling constant λ was calculated from the superconducting critical temperature T_c and Θ_0 and was used to derive the band-structure density of states $N_{b_1}(E_F)$. Both $N_{b_1}(E_F)$ and λ increase more rapidly with increasing tin content above 9 at.% tin than below 9 at.%. These results are interpreted in terms of the Brillouin-zone-boundary–Fermi-surface interaction that has been postulated to explain the behavior of the lattice parameters and T_c. Comparison with band-structure calculations and experimental Fermi-surface studies for pure indium suggest that new parts of the Fermi surface appear in the third zone at this electron concentration. (auth)

22636 HIGH-TEMPERATURE SUSCEPTIBILITY OF URANIUM COMPOUNDS WITH Th_3P_4-TYPE CRYSTAL STRUCTURE. Troc, R.; Mulak, J.; Suski, W. (Inst. for Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi (b); 43: 147-156(1 Jan 1971).

Magnetic-susceptibility measurements for six uranium compounds with P, As, Sb, Bi, Se, and Te having Th_3P_4-type crystal structure were performed in the temperature range 77 to 1200°K. In the higher temperature region, the dependence of χ^{-1} on T is found to be curvilinear for all these compounds. The experimental results, corrected for the presence of magnetic exchange interactions, are compared with theoretical ones obtained by taking into account the influence of the crystal field on the central U^{+4} ion in the tetragonal D_{2d} symmetry. The increase of the paramagnetic moment of U^{+4} in U_3X_4 compounds from 2.75 to 3.14 μ_B is explained by the assumption that the pseudodoublet is the ground state. The anisotropy of the magnetic properties of an individual U^{+4} ion and the relation between the paramagnetic and the ferromagnetic moment are theoretically established and found to be in accordance with the experiment. (auth)

22637 PRESSURE EFFECT OF THE FERMI SURFACE OF MOLYBDENUM AND TUNGSTEN. Pluzhnikov, V. B.; Svechkarev, L. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi (b); 43: k55-7(1 Jan 1971).

The pressure dependence of the Fermi surface cross sections of hole ellipsoids of Mo and W related to the $N_{1'}$ level was studied. The phase shift of the de Haas–van Alphen oscillations was registered in a fixed magnetic field at pressures up to 120 atm. The difference between the pressure effect in Mo and that in W shows sensitivity to potential structure. (D.L.C.)

22638 DIELECTRIC AND ANELASTIC RELAXATION IN Ca-DOPED CERIUM DIOXIDE. Lay, K. W.; Whitmore, D. H. (Northwestern Univ., Evanston, Ill.). Phys. Status Solidi (b); 43: 175-90(1 Jan 1971).

Measurements of dielectric losses and internal friction in Ca-doped CeO_2 were made over the temperature range 253 to 573°K on specimens with up to 2.5% of the Ce^{4+} ions replaced by Ca^{2+} ions. The observed internal friction and dielectric loss peaks have relaxation times in close accord with the predictions of an eight-position nearest-neighbor model, namely, that the relaxation time for electrically active modes is equal to twice that for mechanically active modes. These relaxations occur because of the redistribution of oxygen vacancies (bound to substitutional Ca^{2+} ions) among eight sites which are initially equivalent, but which become inequivalent in the presence of the external electric or mechanical stress field. From the temperature dependence of the relaxation times and the peak shape, the activation energy required for such oxygen vacancy jumps is calculated to be 0.86 eV, with the pre-exponential factor estimated to be 2.4×10^{14} sec^{-1}. (auth)

22639 TEMPERATURE VARIATION OF THE FREQUENCY OF LONGITUDINAL INTERPLANAR OSCILLATIONS IN PYROLITIC GRAPHITE. Roy, A. P. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: 277-9(15 Jan 1971).

The zone-boundary longitudinal phonon frequency, propagating along the hexad axis in pyrolytic graphite, was measured by neutron spectrometry at 200 to 900°K. The relative frequency change for this temperature interval, $\Delta\nu/\nu$, is 0.07, a very high value in view of the lower limit for the melting temperature for graphite of 3800°K. (auth)

22640 SPIN DYNAMICS IN Tb STUDIED BY CRITICAL NEUTRON SCATTERING. Dietrich, O. W.; Als-Nielsen, J. (Danish Atomic Energy Commission Research Establishment, Risoe). J. Phys., C (London); 4: 71-9(1971).

The inelasticity of the critical neutron scattering in Tb was measured at and above the Néel temperature. In the hydrodynamic region the line width $\Gamma(q = 0, \kappa_1) = c\kappa_1^z$, with $z = 1.4 \pm 0.1$ and $c = 4.3 \pm 0.3$ MeV Å^z. This result deviates from the conventional theory, which predicts that $\Gamma(q = 0, \kappa_1)$ is inversely proportional to the static susceptibility, that is $z = 2$. In the critical region it was found that $\Gamma(q,\kappa_1 = 0) = \Lambda q^\delta$, with $\delta = 2.0 \pm 0.1$ and $\Lambda = 7.5 \pm 0.7$ MeV Å$^\delta$. The prediction of the dynamical scaling laws that $\delta = z$ is thus not fulfilled. (auth) (UK)

22641 MAGNETIC DOMAIN STRUCTURE OF TERBIUM SINGLE CRYSTALS. Corner, W. D.; Al-Bassam, T. S. (Univ. of Durham, Eng.). J. Phys., C (London); 4: 47-52(1971).

A single crystal of terbium was obtained in which the oxide content had been considerably reduced by a solid-state electrolysis technique. The domain structure in a cube-shaped sample was observed at 210°K and different possibilities for the internal domain configuration are considered. Agreement is found between experimental observations and a proposed model that consists of plate-type domains magnetized along the b_1 and b_3 axes but not along the b_2 axis, which is perpendicular to one surface. The equilibrium domain width was measured and compared with that calculated for this model, and agreement was found to be good. The structure at lower temperatures was studied, but it is still not clear whether the pattern observed represents a true domain structure. (auth) (UK)

22642 STUDY OF EXTENDED DEFECTS BY X-RAY AND NEUTRON DIFFRACTION. Willis, B. T. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 272-94 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

Solids with extended defects scatter x-ray or neutron radiation into the Bragg peaks and into diffuse (non-Bragg) regions of reciprocal space, by means of elastic scattering processes. Information relating to the structure of the defects is obtained by measuring the intensity distribution in both the Bragg peaks and the diffuse regions. Nonstoichiometric compounds are considered where the deviation from stoichiometry is due to extended defects in the form of defect complexes (clustered point defects) distributed without long-range order throughout the solid. Formulas for the theoretical Bragg and diffuse intensities are given in terms of the structural features of the extended defects, and experimental techniques suitable for measuring the scattered intensity are briefly discussed. Some selected results are reviewed on nonstoichiometric compounds with defective rocksalt and fluorite structures. (auth)

22643 USE OF ELECTRON MICROSCOPY IN THE STUDY OF EXTENDED DEFECTS RELATED TO NONSTOICHIOMETRY. Amelinckx, S.; Van Landuyt, J. (SCK–CEN, Mol, Belgium. Rijksuniversitair Centrum, Antwerp). pp 295-322 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

Examples of structures and defect structures, studied by means of electron microscopy and electron diffraction are discussed. Attention is drawn to the difficulties associated with the definition of a crystallographic phase, which arise because of the use of high-resolution methods of observation. The relation between the

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presence of planar defects and nonstoichiometry is briefly discussed and, in particular, the defect structure of WO_3 is considered in this respect. Experimental evidence is presented for the occurrence in TiO_2 of interfaces that have the characteristics of "shear" planes, of the type that occur in shear structures. The ordering of structural vacancies is shown to give rise to interfaces of different type in In_2S_3. From the study of the mobility of these interfaces it is concluded that indium ions in tetrahedral interstices become disordered at lower temperature than the indium ions in octahedral interstices. In tealite ($PbSnS_2$), it is possible to use dislocation ribbons as probes for measuring the chemical effect on the stacking-fault energy. (auth)

22644 STRUCTURAL, ELECTRICAL, AND MAGNETIC PROPERTIES OF VACANCY-STABILIZED CUBIC TiO AND VO. Banus, M. D.; Reed, T. B. (Massachusetts Inst. of Tech., Lexington). pp 488-522 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids. Scottsdale, Ariz. See CONF-690450.

The cubic compounds TiO_x and VO_x have a wide nomogeneity range with x varying from about 0.75 to 1.30, and a total vacancy content as high as 20%. They are interesting because of the continuous change of structural, chemical, physical, and electrical properties across this homogeneity range. Previous work on these compounds is summarized briefly, showing many disagreements in the published data. This paper presents a consistent body of data on the lattice parameter, density, electrical resistivity ρ, Seebeck coefficient α, and magnetic susceptibility χ_M for about thirty carefully characterized samples of each. The concentration of metal and of oxygen vacancies V_M and V_O are ~15% at $TiO_{1.0}$ and $VO_{1.0}$, and V_M increases with x, while V_O decreases, becoming zero at the cubic phase boundary. For TiO_x, as x increases ρ and $d\rho/dT$ (negative) are small and increase slightly, α (n-type) increases, and χ_M is extremely small and unchanging, indicating that TiO is a typical metallic oxide. Annealing TiO at 50 to 60 kbar and 1300° decreases the total vacancies without changing the other properties significantly. However, pressure annealing increases the superconducting transition temperature T_c by >1.0°K over the entire composition range. The electrical and magnetic properties of VO_x are strongly dependent on composition and temperature. With increasing x, ρ, $d\rho/dT$ (negative) and χ_M increase linearly with abrupt increases in slopes at x = 1.0, while α changes smoothly from n-type to p-type at x = 1.02. No metal–semiconductor transition was observed for any composition on decreasing temperature to 77°K. These results suggest that oxygen-rich VO is a semiconductor with a small energy gap which decreases with x so that metal-rich VO is a semi-metal. However, the correct explanation for all these data must explain how changes in vacancy content affect the available electron concentration as well as the band structure. (auth)

22645 EFFECT OF EXTENDED DEFECTS ON THE ELECTRICAL PROPERTIES OF SUBSTOICHIOMETRIC OXIDE SINGLE CRYSTALS. Sienko, M. J.; Berak, J. M. (Cornell Univ., Ithaca, N. Y.). pp 541-54 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

A careful study was made of the electrical conductivity, Hall voltage, and Seebeck effect of WO_3 crystals slightly deficient in oxygen. Crystals ranging in composition from $WO_{2.9877}$ to $WO_{2.9999+}$ were produced by annealing of WO_3 under a variety of oxygen pressures. Measurement of ρ, R_H, and Q on the same crystal along specified crystallographic directions allowed unambiguous definition of carrier concentration and mobility as functions of concentration and temperature. Carrier concentrations are generally somewhat less than would correspond to one electron per oxygen vacancy. Mobilities are about the same as observed in tungsten bronzes, but show a pronounced decrease with increasing oxygen defect concentration. Marked changes are observed in the resistivity behavior at the phase transitions below room temperature. they are due, respectively, to fundamental changes in mobility behavior and to Madelung effects on donor-ionization energies. Transitions are moved to lower temperature as very strong functions of oxygen defect concentration, and the changes in the electrical properties at these transitions become vanishingly small with only small oxygen defect. The total data, including optical crystallography and DTA studies, can be consistently explained only by a model that aligns oxygen defects at much lower concentrations than hitherto suspected. The change in mobility behavior from lattice scattering to hopping is interpreted in terms of a two-region model in which normal WO_3 alternates with a defected region. The large distances over which the ordering forces operate suggest electron delocalization via $W(5d_\epsilon)-O(p\pi)-W(5d_\epsilon)$ molecular orbitals. (auth)

22646 MAGNETIC PROPERTIES OF Tb–Ho SINGLE CRYSTAL ALLOYS. III. NEUTRON DIFFRACTION STUDIES OF Ho RICH ALLOYS. Spedding, F. H.; Ito, Y.; Jordan, R. G.; Croat, J. (Iowa State Univ., Ames). J. Chem Phys.; 54: 1995-2003(1 Mar 1971).

Neutron diffraction studies on several polycrystal and single-crystal samples of Ho-rich Tb–Ho alloys are reported. Polycrystalline samples containing 90, 92, 94, 96, and 98% Ho, as well as pure Ho, were studied at room temperature and at 8°K as a preliminary investigation for subsequent single-crystal work. Three single-crystal samples containing 93, 95, and 98% Ho were studied in detail from room temperature to 4.2°K. Both the Curie and Néel temperatures of the single-crystal alloys were found to decrease almost linearly as the Ho concentration was increased. Both the 93 and 95% Ho alloys were found to have ordered phases similar to that of the 90% Ho alloy, with the exception that fifth and seventh harmonics caused by the distortion of the simple helical arrangement were observed for 95% Ho between 40°K and the Curie temperature at about 15°K. It is found that the magnetic structure of the 98% Ho alloy corresponds to a magnetic structure on the borderline between that of pure Ho and that of 90% Ho. It shows all the characteristic features observed for pure Ho with the important exception that it does not transform to the conical spiral structure. Rather, the moments are still confined to the basal plane, most of them in the distorted helical arrangement bunched around the easy b direction, with some 4.4% of them collapsed into ferromagnetic ordering along the b direction. (auth)

22647 OBSERVATION OF MIXED THERMOELECTRIC POWER IN ThO_2. Tallan, N. M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio); Bransky, I. J. Electrochem. Soc.; 118: 345-9(Feb 1971).

Electrical conductivity measurements were made on high-purity ThO_2 at temperatures between 1000 and 1600°C and oxygen partial pressures of 10^{-1} to 10^{-22} atm. These measurements showed the presence of an oxygen pressure-independent region of ionic conductivity at intermediate oxygen pressures and temperatures below about 1400°C, as well as a transition to predominant electron hole conductivity at high oxygen pressures. The Seebeck coefficient was measured over a wide range of oxygen partial pressures in several different gas mixtures at 1000 and 1200°C. The Seebeck coefficient in the region of pure ionic conduction is shown to be a function of the entropy of oxygen in the gas phase, rather than the oxygen partial pressure, as expected for the ionic Seebeck coefficient in the case of a constant ionic defect concentration. The behavior of the Seebeck coefficient in the mixed conduction region is also discussed. (auth)

22648 EFFECT OF DEFORMATION TEMPERATURE ON THE STAGE III RECOVERY IN NIOBIUM. Amano, Muneyuki; Sasaki, Yasuo (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 34: 1232-7(Dec 1970).

The thermal recovery of the increase in electrical resistivity caused by the deformation of niobium was studied. Polycrystalline niobium wires were strained in tension at temperatures from −196 to 50°C with strain rates of 3.3×10^{-5} to 3.3×10^{-3} sec^{-1}. The increase in electrical resistivity with strain was nearly linear and was strongly dependent upon the deformation temperature. The isochronal recovery curves of specimens revealed the well-defined stage III recovery centered around 160°C and the strain aging was found at this recovery stage by tensile test. The total recovery in this stage increased with decreasing deformation temperature and increasing strain. The effect of strain rate on this recovery was not observed. The resistivities of the specimens, which were stretched by 5% at each temperature and subsequently annealed up to 220°C, showed a negative deviation from the initial resistivity. It is concluded that the recovery in the stage III is mainly caused by the clustering of oxygen atoms to dislocations, and the dependence of the stage III recovery on deformation temperature is attributed to the difference in the dislocation density. The experimental results suggest that the change in dislocation density with strain increases with decreasing temperature. (auth) (Japan)

22649 TEMPERATURE STABILIZATION OF THE MAGNETIC PROPERTIES OF A MOLYBDENUM PERMALLOY. Dmitrova, L. L.; Puzei, I. M. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met.; No. 71, 29-33 (1969). (In Russian).

Studies were made of the effect of a low-temperature isothermal temper on the temperature dependence of the coercive force and permeability at constant inductions of a Mo Permalloy in the temperature range from −196°C to the Curie point. A stabilizing heat-

treatment regime was developed that significantly improved the temperature stability of the coercive force and permeability at various constant inductions. (Referativnyi Zh.)

Moessbauer Effects and NMR

Refer also to abstracts 21421, 21422, 21469, and 23085.

22650 (UCRL-18986) SPIN-LATTICE RELAXATION BY NUCLEAR MAGNETIC RESONANCE ON ORIENTED NUCLEI. Barclay, John Arthur (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1969. Contract W-7405-eng-48. 105p. Dep. NTIS.

Thesis.

Nuclear magnetic resonance was detected at 0.004 to 0.010°K by perturbation of the gamma-ray anisotropy of ^{60}Co in Fe, Co, and Ni. Shirley's work on the response functions describing the perturbation in the presence of homogeneous broadening was extended to include inhomogeneous broadening. The existence of a "hard core" value at resonance is demonstrated in this case also. Frequency modulation of the inhomogeneous line was necessary in order to perturb all of the spin packets in the broadened lines. The optimum conditions for frequency modulation were found by varying the modulation bandwidth and modulation frequency. A simple model was proposed to explain the observed degree of perturbation. In addition, nuclear spin–lattice relaxation times were measured in the 0.004 to 0.010°K temperature range. Interpretation of the data was done by fitting the data with a sum of exponentials. Precise T_1 results are obtained but the accuracy was uncertain due to the uncertainty of the initial conditions. (auth)

22651 PREPARATION OF LINE MOESSBAUER ^{57}Co SOURCES. Artem'ev, A. N.; Mirzababaev, R. M.; Sklyarevskii, V. V.; Smirnov, G. V. (Inst. of Atomic Energy, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 715-7(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 74-6(May-Jun 1970).

The method of preparing line Moessbauer ^{57}Co sources of a high specific activity is described. The possibility of obtaining sources with an activity of hundreds of $\mu Ci/mm^2$ is shown. (auth)

Theory

22652 NONSTOICHIOMETRIC AND ORDERED PHASES: THERMODYNAMIC CONSIDERATIONS. Anderson, J. S. (Oxford Univ.). pp 1-20 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids, Scottsdale, Ariz. See CONF-690450.

This introductory paper does not review nonstoichiometric and other extended defect systems, but directs attention to several areas in which there are real uncertainties, perhaps room for controversy, and a need for clearer recognition of the real problems. This is done under three main headings: our actual knowledge, in operational terms as distinct from the interpretations usually put upon the facts after some step of inference; the thermodynamic factors, independent of particular models, that determine the relative stability of phases and structures; and the alternative bases on which theoretical models can be erected. These headings embrace the three strands of structure, thermodynamics, and statistical thermodynamics. (auth)

22653 SPACING STATISTICS AND THE DISTRIBUTION OF INTERACTING LATTICE DEFECTS. Atlas, Leon M. (Argonne National Lab., Ill.). pp 425-43 of Chemistry of Extended Defects in Non-Metallic Solids. /Eyring, LeRoy (ed.). Amsterdam; North-Holland Publishing Company (1970).

From Conference on the Chemistry of Extended Defects in Non-Metallic Solids. Scottsdale, Ariz. See CONF-690450.

A system of statistics is developed for calculating the distribution of point defects or other interacting particles that may be referred to a lattice. In this system, a defect can occupy any eligible lattice point with equal probability, and in doing so, it removes C-i lattice points from the total available to other defects. This does not mean that the defect physically prevents others from occupying the withdrawn sites; the number C-i is simply a reciprocal of the local defect concentration—a measure of the local spacing. Assigning a set of standard values to i generates a set of spacing levels and a corresponding set of energy levels. Distribution functions that express the fraction of a defect population in each spacing and energy level are derived, both for a single assembly of defects and for two assemblies arranged on separate sublattices. These distributions are applied to partition functions of the defects that are used to calculate the relative partial molar entropy, enthalpy, and free energy of oxygen in UO_{2+x}. (auth)

Theoretical Physics

Refer also to abstracts 21383, 22218, 22430, and 22882.

22654 (CNRS-CPT-70-P-353) NOTE ON QUANTUM DYNAMICAL SYMMETRIES. De Angelis, G. F.; Vilasi, G. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). 1970. 13p. Dep. NTIS (U. S. Sales Only).

The problem is considered of finding, for a given quantum system, a compact Lie group of symmetries such that to any energy level there corresponds an irreducible representation of the group. It is concluded that this is only possible in particular cases, and that, in general, to a given energy level there corresponds a reducible representation of the group. Examples of such behavior are given. (France)

22655 STUDIES OF TRANSITION RADIATION OF RELATIVISTIC ELECTRONS. Genning, A. F. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 134-6(1970). (In Russian).

Transition radiation from relativistic electrons with energy from 0.8 to 1.8 MeV was studied, using the Van de Graaff electrostatic generator as an electron source and FEU-31 detector capable of measuring the distribution of the radiation at 10 to 80° to the direction of the electron emission. Angular distribution of the transition radiation and its intensity growth with electron energy increase showed good agreement with theory. (R.V.J.)

22656 LINEAR DIFFERENTIAL EQUATION FOR THE RADIAL DISTRIBUTION FUNCTION OF QUANTUM MECHANICS. Kostin, M. D. (Princeton Univ., N. J.). J. Chem. Phys.; 54: 2739-41(15 Mar 1971).

A nonlinear equation for the probability density of quantum theory is obtained from the Schroedinger equation for the case of complex wave functions. Motion of a particle in a centrally symmetric field is investigated and it is found that a linear differential equation for the radial distribution function can be derived. The linear equation is used to demonstrate the transition to classical theory and to derive a partial differential equation for the radial distribution function of statistical thermodynamics. (auth)

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PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 22720, 22722, and 22921.

22657 QUARKS AND THE SEC θ LAW. Kim, Y. S. (Ohio State Univ., Columbus). Lett. Nuovo Cim.; 1: 300-4(13 Feb 1971).

A hypothesis is discussed for the isotropic and excess muons in cosmic rays reported previously. According to this hypothesis these isotropic and excess particles are really quarks with a large mean elasticity and a relatively long interaction length. Experimental evidence which is consistent with this hypothesis is considered. (J.F.P.)

Electromagnetic

Refer also to abstract 21438.

22658 (DESY-70/65) ELECTROPRODUCTION OF $\Delta(1236)$ IN THE π^0 CHANNEL AT A FOUR MOMENTUM TRANSFER OF 25 f^{-2}. Albrecht, W.; Brasse, F. W.; Dorner, H.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Dec 1970. 14p. Dep. NTIS (U.S. Sales Only).

The electroproduction of the $\Delta(1236)$ was investigated by measuring angular distributions of the outgoing proton. Coefficients of these angular distributions for a wide mass range around the resonance are given at a momentum transfer of 25 fm^{-2}. Also given are the resonant multipoles in a small range around the resonance. The γNN^* form factor obtained from the work at 15 and 25 fm^{-2} is compared with other results. (auth)

22659 (DESY-71/2) FITS TO ELECTROPRODUCTION DATA IN THE RESONANCE REGION AND CONSEQUENCES FOR σ_l/σ_t. Brasse, F. W.; Fehrenbach, W.; Flauger, W.; Frank, K. H.; Gayler, J.; Korbel, V.; May, J.; Zimmerman, P. D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan 1971. 22p. Dep. NTIS (U.S. Sales Only).

All published measurements of electroproduction cross sections, where only the scattered electron was detected, were used to get some information for the ratio σ_l/σ_t in the resonance region. The experimental cross sections were fitted in the absolute value of the three momentum transfer $|\vec{q}|$ independently for small bins of W across the range $1.11 \leq W \leq 1.99$ GeV. This was made for two ranges of the polarization ϵ of the virtual photon. In one range ϵ was restricted to $\epsilon \geq 0.9$, in another one to $\epsilon \leq 0.6$. By comparing cross sections resulting from these fits for the two ranges of ϵ, but for the same values of q^2 and W, a significant σ_l contribution is not found. Taking into account the size of errors upper limits can be put on $R = \sigma_l/\sigma_t$. These are about $R \leq 0.2$ for $0.5 \leq q^2 \leq 2.0$ $(GeV/c)^2$ and $R \leq 0.35$ for $2.0 < q^2 \leq 4.0$ $(GeV/c)^2$ over the whole range of W as indicated above. (auth)

22660 (SLAC-129) INELASTIC ELECTRON SCATTERING AT LARGE ANGLES. Miller, Guthrie (Stanford Linear Accelerator Center, Calif.). Jan 1971. Contract AT(04-3)-515. 141p. Dep. NTIS.

Electron-proton scattering cross sections were measured at electron scattering angles of 18, 26, and 34° for incident electron energies up to 18 GeV. These data extend in four momentum transfer squared (q^2) from 1 to 20 GeV^2 and in missing mass squared (W^2) up to 25 GeV^2. Using previously reported data at 6 and 10°, a separation of the two inelastic form factors was made in the deep inelastic region ($W^2 > 4$ GeV^2) for q^2 from 1.5 to 8 GeV^2. The transverse form factor is found to dominate in agreement with the expectations of various "parton" theories (for spin $\frac{1}{2}$ partons). Determination of the inelastic form factor W_2 allowed an investigation of the question of "scaling" i.e. that $\nu W = F(\nu/q^2)$ in the deep inelastic large q^2 region. (auth)

22661 INVESTIGATION OF THE ϕ-MESON RESONANCE BY ELECTRON-POSITRON COLLIDING BEAMS. Balakin, V. E.; Budker, G. I.; Pakhtusova, E. V.; (and others) (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 34B: 328-32(1 Mar 1971).

Using the colliding beam machine, VEPP-2, the excitation curve of the ϕ-meson resonance was investigated in the three main decay modes. The resonance parameters obtained are the width, the total cross-section and the branching ratios. Namely: $\Gamma = (4.67 \pm 0.42)$ MeV, $\sigma_0 = (3.96 \pm 0.35)$ μB, $B(e^+e^-) = (2.81 \pm 0.25) \times 10^{-4}$, $B(K^+K^-) = (54.0 \pm 3.4)$ %, $B(K_S^0K_L^0) = (25.7 \pm 3.0)$ %, and $B(\pi^+\pi^-\pi^0) = (20.3 \pm 4.2)$ %. In addition, the pion form factor at 2E = 1020 MeV is obtained together with an upper limit for branching ratio of the ϕ-meson decay into a pion pair: $|F_\pi|^2 = 2.9 \pm 1.2$, $B(\pi^+\pi^-) < 0.8$%. (auth)

22662 DOUBLE PION PHOTOPRODUCTION BELOW 1 GeV: EXPERIMENTAL RESULTS. Diambrini-Palazzi, G.; Giannini, I.; Grianti, F.; (and others) (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Lett. Nuovo Cim.; 1: 267-72(13 Feb 1971).

The interaction $\gamma + p \rightarrow \pi^+ + \pi^- + p$ below 1 GeV was studied. The invariant mass distributions and proton angular distributions are shown. It is concluded that the general behavior of the data shows that a contribution of a P_{11} intermediate state with a mass of 1400 MeV is required. (J.F.P.)

Weak

22663 (NYO-2419-18) PRODUCTION OF LOW ENERGY MUONS BY NEUTRAL COMPONENTS OF THE COSMIC RADIATION AT SEA LEVEL. Final Report. Cowan, Clyde L. (Catholic Univ. of America, Washington, D. C.). 31 May 1970. Contract AT(30-1)-2419. 29p. Dep. NTIS.

The discussion of this experiment covers the telescope used and a summary of results thus far. The number of events found is 76 at a rate of 0.74 events per day. A charge ratio $\mu^-/\mu^+ = 1.15$ is found. The zenith-angle distribution is also discussed. (J.F.P.)

22664 STUDY OF THE MUON MOMENTUM SPECTRUM AND POSITIVE-NEGATIVE RATIO AT SEA-LEVEL. Appleton, I. C.; Hogue, M. T.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Phys., B26: 365-89(1971).

The momentum spectrum and the variation of the positive-negative ratio with energy of single cosmic-ray muons arriving at sea-level in the near vertical direction was measured at Nottingham using a solid iron magnet spectrometer. The data on the spectrum includes earlier work and extends over the momentum range 3 GeV/c < p < 1000 GeV/c. The high-momentum portion of the spectrum is based on some 5000 particles of momentum greater than 22 GeV/c. Comparison of the present spectrum with the results of other workers shows agreement between the basic data although some uncertainty has been found to be associated with the different normalization procedures adopted. The results of the variation of the positive-negative ratio with energy show that the previously reported increase with increasing energy was probably due to the lack of adequate statistical accuracy. The positive-negative ratio as determined from this experiment appears to be consistent with a constant value of 1.25 over the entire energy range. (auth)

22665 INTERFERENCE OF K_L AND K_S $\pi^+\pi^-$-DECAY AMPLITUDES BEHIND THE REGENERATOR. Balats, M. Ya.; Berezin, V. M.; Vishnevskii, M. E.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 93-103(Jan 1971). (In Russian).

Interference of the K_L and K_S $\pi^+\pi^-$-decay amplitudes behind the Cu regenerator was investigated. The phase difference is measured: $\varphi_+ - \arg if_{12}(0) = (82° \pm 11°) + 225°\,(\delta - 0.469)$. Calculated values of the regeneration phase, $\arg if_{12}(0)$, were used to find the φ_+ phase, that characterizes the CP violation. The result is $\varphi_+ = (39° \pm 12°) + 230°\,(\delta - 0.469)$. The K_L-K_S mass difference is found to be $\delta = (m_L - m_S)\,\tau_S = 0.415^{+0.006}_{-0.005}$. The amplitude ratio, $|f_{12}(0)/\eta_+| = (5.39 \pm 0.56) \cdot (10)^{-18}$ cm, and the total K_L-Cu interaction cross section, $\sigma_t = 1027 \pm 90$ mbarn, are also measured for the mean K^0 momentum $p_{K^0} = 1.9$ GeV/c. (auth)

22666 EXPERIMENTAL DETERMINATION OF THE K_S^0 CHARGED TO NEUTRAL BRANCHING RATIO AND $|\Delta I| > 1/2$ TRANSITIONS. Morfin, Jorge Guillermo. Ann Arbor, Mich.; Univ. of Michigan (1970). 199p. University Microfilms Order No. 71-4684.

Thesis.

The Michigan-ANL 40-inch heavy liquid bubble chamber filled with heavy Freon, CF_3Br was exposed to a separated K^+ beam at the ZGS complex of Argonne National Laboratory. Approximately 150,000 pictures were taken at a transport momentum of 825 MeV/c. An auxiliary exposure of ~20,000 pictures using a π^+ beam of the same transport momentum was also obtained for determination of π^+ contamination of the K^+ beam. The resulting K^+ sample was scanned for the charge exchange reaction $K^+ + n \rightarrow K^0 + p$.

Through subsequent edits those K^0's produced by the above reaction and decaying via the short-lived mode, K_1^0, were categorized as to whether their decay products were two charged pions ($\pi^+ + \pi^-$) or two neutral pions ($\pi^0 + \pi^0$). The raw sample of 7500 $K_2^0 \rightarrow \pi^+ + \pi^-$ decays was then subjected to four corrections while the raw sample of 4280 $K_2^0 \rightarrow \pi^0 + \pi^0$ decays underwent six corrections. The corrected charged and neutral samples contained 7736 ± 99 and 3654 ± 100 events, respectively. With the resulting K_2^0 charged to neutral branching ratio of 2.117 ± 0.064 the difference in $\pi\pi$ phase shifts $|\delta_0^2 - \delta_0^0|$ where δ_0^2 and δ_0^0 are the s-wave isotensor and isoscalar phase shifts, respectively was investigated. Assuming no $\Delta I = 3/2$ transitions $|\delta_2 - \delta_0| = (72^{+}_{-}\frac{5}{6})^0$ was found. Also the relative magnitudes of I = 2 and I = 0 states in the composition of the 2π final state were investigated and $\mathrm{Re}(A_2/A_0) = 0.022 \pm 0.014$ was found. Using the results of this last investigation the relative magnitudes of $\Delta I = 5/2$ and $\Delta I = 3/2$ transitions in the $K_1^0 \rightarrow 2\pi$ decay were examined. This ratio was found to be $\alpha_5/\alpha_3 = 0.391 \pm 0.510$ or -2.18 ± 2.85. As a check on the experimental method, a careful tabulation of all K_L^0 production was kept. After five corrections were applied to the raw sample the total K_L^0 production was compared to the total K_S^0 production and an estimate of the phase of the amplitude for coherent regeneration in Freon, $(-40 \pm 25)^0$, was obtained. The phenomenology of $K_2^0 \rightarrow 2\pi$ decays including regeneration and interference phenomena is examined. Also a resume is given of the status regarding $\pi\pi$ phase shifts. (Diss. Abstr. Int., B)

22667 MEASUREMENTS OF THE LIFETIMES OF POSITIVE AND NEGATIVE PIONS. Ayres, David S. (Univ. of California, Berkeley); Cormack, Allan M.; Greenberg, Arthur J.; (and others). Phys. Rev., D; 3: 1051-63(1 Mar 1971).

The experiment described here compares the lifetimes of π^+ and π^- by measuring the fraction of surviving pions at several positions along a 1000-cm (one-half lifetime) decay path. The result of the measurement, $\tau(\pi^+)/\tau(\pi^-) = 1.00055 \pm 0.00071$, is consistent with the CPT theorem, which predicts that a particle and its antiparticle have equal lifetimes. The beam polarity was alternated frequently between positive and negative particles, and many precautions were taken to ensure that the π^+ and π^- beams were identical in their spatial and momentum distributions. Most of the running time was spent investigating possible sources of systematic bias which might make the lifetimes appear to be different, and a number of these systematic errors were found and eliminated. Using a time-of-flight determination of the pion velocity, a value of the charged-pion lifetime $\tau = 26.02 \pm 0.04$ nsec was obtained. The good agreement between this value for pions in flight and the result of independent measurements with pions at rest provides the most precise verification of time dilation. In the model of Lundberg and Rédei this comparison sets an upper limit on a fundamental length of 3×10^{-15} cm. The velocities of the π^+ and π^- beams were compared by time of flight and the momenta by use of a magnetic spectrometer. Together the measurements determine $m(\pi^+)/m(\pi^-) = 1.0002 \pm 0.0005$. (auth)

Strong (Baryon-Induced)

22668 (INP-712(Vol.1), pp 144-72) SCATTERING OF HIGH ENERGY PROTONS FROM NUCLEI. Palevsky, H. (Brookhaven National Lab., Upton, N. Y.).

In Proceedings of the X Cracow School of Theoretical Physics. Volume I.

Studies of high-energy proton scattering by nuclei are performed in order to understand whether the nucleons inside the nucleus are the same entities as free nucleons. The method of measurement at the Cosmotron is described, and some of the results pertinent to the study of correlations are given. (J.F.P.)

22669 (SJC-P-70-1) MESON RESONANCES AS OBSERVED IN $\bar{p}p$ ANNIHILATIONS. Montanet, L. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Mar 1970. 108p. Dep. NTIS (U.S. Sales Only).

This is a review on meson resonances as observed in $\bar{p}p$ annihilations at CERN. The properties of several meson resonances were analyzed in some detail: spin-parity of k* (891); mass, width, branching ratio of ω, ψ; a new S = 1 meson, at M = 1260 MeV, $J^P = 1^+$, the C meson: $C \rightarrow KP$, $C \rightarrow k^*\pi$; a new S = 0 meson, at M = 1420 MeV, $J^P = 0^-$ (or 1^+?), I = 0, C = +1, the E meson: $E \rightarrow k^*k$, $E \rightarrow k\bar{k}\pi$, a new S = 0 meson, at M = 1280 MeV, $J^P = 1^+$ (?), I = 0, C = +1, the D meson: $D \rightarrow k^*k$, $D \rightarrow k\bar{k}$, $D \rightarrow n\pi\pi$; a new S = 0 meson, at M = 1540 MeV, $J^P = 2^-$ (?), I = 1, the F_1 meson: $F_1 \rightarrow k^*k$; a new $k\bar{k}$ threshold effect, in I = 1, which may be related to the S-meson; mass, width and quantum numbers of the S*(1040); splitting of the A_1 meson in its $k\bar{k}$ decay mode; a new determination of the $\pi\pi$P-wave (P) parameters; mass, width, spin and parity of the B(1220) $\rightarrow \omega\pi$; determination of the $\pi\pi$ S-wave parameters between $2m_\pi$ and 1.1 Gev. As is shown by these analyses, one of the advantages of $\bar{p}p$ annihilations which is very useful for a detailed analysis of the final states is that the $\bar{p}p$ annihilations at rest occur in well defined states, $^1S_0$ and $^3S_1$. (Japan)

22670 THE REACTION $p + p(\uparrow) \rightarrow \pi^+ + d$ BETWEEN 1.0 AND 1.5 GeV/c. Albrow, M. G.; Andersson-Almehed, S.; Bosnjakovic, B.; (and others) (CERN, Geneva). Phys. Lett.; 34B: 337-42(1 Mar 1971).

Polarization data for the reaction $pp \rightarrow \pi^+ d$ on polarized protons at 1.04, 1.13, 1.21, 1.37, and 1.45 GeV/c are presented. The coefficients characterizing the angular distribution of the polarization show an energy dependence similar to that of the total cross section and are consistent with the view that $N^*(\frac{3}{2}, \frac{3}{2})$ production dominates the reaction mechanism. (auth)

22671 EVIDENCE OF NEUTRAL F_1 PRODUCTION IN $\bar{p}p$ ANNIHILATIONS AT 1.1 TO 1.2 GeV/c. Duboc, J. (Institut de Physique Nucleaire, Paris); Goldberg, M.; Makowski, B.; (and others). Phys. Lett.; 34B: 343-5(1 Mar 1971).

The F_1^0 was observed in the reaction $\bar{p}p \rightarrow K_1^0 K^+ \pi^-$ (MM), mainly in the channel $\bar{p}p \rightarrow F_1^0 \eta^0$. The quantum numbers of the F_1^0 were studied. The only assignments compatible with experiment are $J^{PC} = 1^+$ or 2^+. (auth)

22672 MECHANISM OF COHERENT PRODUCTION OF PARTICLES BY PROTONS WITH MOMENTUM OF 19.8 GeV/c. Boos, E. G.; Takibaev, Zh. S.; Tursunov, R. A. Vestn. Akad. Nauk Kaz. SSR; No. 2, 42-8(Feb 1970). (In Russian).

The process of coherent production of particles by high-energy protons on the nuclei of Ilford G-5 emulsions is studied. The analysis of the criterion of separation of the coherent events according to the magnitude of the longitudinal momentum transferred to the nucleus is adduced. Comparison with the results of work performed using the bubble chamber indicates good agreement of the average range value, which was obtained with this chamber. The analysis of the distributions according to the effective mass does not contradict the conclusion regarding the formation of the nucleon isobar N^* (1470) in the considered events. (tr-auth)

22673 FOUR- AND FIVE-PION PRODUCTION IN pp COLLISIONS AT 6.92 GeV/c. Danieli, S. (Weizmann Inst. of Science, Rehovoth, Israel); Shapira, A.; Eisenberg, Y.; (and others). Nucl. Phys.; B27: 157-72(1971).

A study was made of pp interactions at 6.92 GeV/c incident lab momentum leading to six and more charged non-strange particles. The values for the six- and eight-prong cross sections were found to be 1.08 ± 0.07 and 0.02 ± 0.01 mb respectively. The behavior of the normalized average matrix-element squared as a function of incident momentum for the six- and seven-body final states and the predictions of the quark additive model have been investigated. The cm angular distributions and the longitudinal and transverse momenta distributions for the outgoing particles are presented and discussed. The production of isobars and mesons was investigated. Cross sections for the production of $\Delta^{2+}(1236)$, $\Delta^-(1236)$, N*(1525) and ω-meson are presented. The angular correlation parameters for the multi-pion systems are given. (auth)

22674 PRODUCTION SPECTRUM OF PIONS IN HIGH-ENERGY PROTON–PROTON COLLISIONS. Boeggild, H.; Hansen, K. H.; Suk, M. (Univ. of Copenhagen). Nucl. Phys.; B27: 1-12(1971).

The Feynman scaling law for the production of pions in high-energy proton-proton collisions is discussed in terms of data on pion production from a 19 GeV/c bubble chamber study, counter data in the range of beam momenta 12 to 30 GeV/c, and data on the average number of pions produced in proton-proton collisions in the range of beam momenta 100 to 800 GeV/c. The result of the analysis yields support for the Feynman scaling law. (auth)

22675 Λp INTERACTIONS IN MOMENTUM RANGE 300 TO 1500 MeV/c. Kadyk, J. A.; Alexander, G.; Chan, J. H.; Gaposchkin, P.; Trilling, G. H. (Univ. of California, Berkeley). Nucl. Phys.; B27: 13-22(1971).

A sample of approximately 250 Λp interactions was obtained in the Λ-hyperon momentum range of about 300 to 1500 MeV/c. An enhanced Λ-hyperon production rate was obtained by exposing an internally-mounted platinum target to the incident 1.5 GeV/c meson beam. Cross sections and angular distributions are obtained for the reactions: $\Lambda p \rightarrow \Lambda p$, $\Lambda p \rightarrow \Sigma^0 p$ and $\Lambda p \rightarrow \Lambda p \pi^0$. In the elastic channel, no strong evidence is seen near the $\Sigma^0 p$ threshold for the presence of a $^3S_1$ resonance, which has been reported, although there is some evidence for a small enhancement in this mass region. There is evidence for the presence of P-waves and probably

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also D-waves above about 800 MeV/c, but not below this momentum. (auth)

22676 SEARCH FOR PARTICLES WITH THE CHARGE-$\frac{4}{3}$ (DIQUARKS) ON THE 70-GeV ACCELERATOR OF IHEP. Antipov, Yu. M.; Ecn, F. A.; Zaitsev, A. M.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 13: 130-4(Jan 1971). (In Russian).

Results are presented of the experiment on search for particles with charge $-\frac{4}{3}$ (diquarks) and momentum of 17.8 GeV/c in the beam of negative particles produced by protons with energy of 70 GeV at an angle of 47 MRad on the Al target. Spectrometric scintillation counters and Cherenkov gas counters were used to identify the diquarks by their charge and velocities. The total number of particles passed through the device during the experiment was $3.9(10)^{10}$. No particles with charge $-\frac{4}{3}$ were detected. The following upper limits are obtained for the differential production cross sections for the diquarks with mass M_Q in pN collisions (with 90% confidence): $d^2\sigma_Q/d\Omega dp_Q < 1.6(10)^{-36}$ cm^2/sterad (GeV/c), $1.9 \leq M_Q \leq 2.3$ GeV/c^2 and $2.7 \leq M_Q \lesssim 4.4$ GeV/c^2; $d^2\sigma_Q/d\Omega dp_Q < 3.8(10)^{-36}$ cm^2/sterad(GeV/c), $2.3 \leq M_Q \leq 2.7$ GeV/c^2. The total cross section for production of the diquarks in the pN collisions in the studied mass range is no more than $(1 \text{ to } 5)(10)^{-36}$ cm^2. (auth)

22677 STUDY OF DYNAMICS OF RESONANCE PRODUCTION IN FOUR-PRONG PROTON–PROTON COLLISIONS AT THE MOMENTUM OF 10 GeV/c. Takibaev, Zh. S.; Boos, E. G.; San'ko, L. A.; (and others) (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 13: 113-23(Jan 1971). (In Russian).

Reaction channels without neutral particles and with production of a single π^0 meson or a neutron are investigated by means of a 81-cm hydrogen bubble chamber. The cross sections of the channels are obtained and it is shown that the nucleon isobar production dominates all the channels. Two-particle reactions like $pp \rightarrow NN'$ and $pp \rightarrow N'N'$ are extracted. Comparison with the results obtained at other energies is carried out. (auth)

22678 PRODUCTION OF NEGATIVE PARTICLES WITH LOW MOMENTA BY 70-GeV PROTONS. Antipov, Yu. M.; Vishnevskii, N. K.; Gorin, Yu. P.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 13: 135-8(Jan 1971). (In Russian).

Yields are measured of negative pions, and kaons, antiprotons and antideuterons produced by protons with the energy of 70 GeV on Al and Be nuclei with the momenta 10 and 13.3 GeV/c. Cherenkov gas counters and the time-of-flight spectrometer were used for identification of the particles. (auth)

22679 SOME FEATURES OF PARTICLE MULTIPLICITIES AND MOMENTUM SPECTRA IN INELASTIC PROTON–PROTON COLLISIONS AT 19 GeV/c. Boeggild, H. (Univ. of Copenhagen); Dahl-Jensen, E.; Hansen, K. H.; (and others). Nucl. Phys.; B27: 285-313(1971).

Various general features of inelastic proton-proton collisions at 19 GeV/c, as they appear in a 2 m hydrogen bubble chamber, were studied, and results concerning particle multiplicities in the final states and single-particle momentum spectra are presented. It is found that the average numbers of produced pions are $\langle n_{\pi^-} \rangle = 1.0$, $\langle n_{\pi^0} \rangle = 1.4 \pm 0.1$, $\langle n_{\pi^+} \rangle = 1.6$. The variation of the average cm momentum of π^- with the number of produced pions is studied, and the fraction of the cm energy available for particle production, which is carried away by the pions, is estimated to be 52%. (auth)

22680 FOUR-PION FINAL STATE IN $\bar{p}p$ ANNIHILATIONS AT 940 MeV/c. Burns, R. R.; Condon, P. E.; Donahue, J.; Mandelkern, M. A.; Schultz, J. (Univ. of California, Irvine). Nucl. Phys.; B27: 109-24(1971).

Results are reported on the four-pion final state from antiproton annihilations in hydrogen in the vicinity of 940 MeV/c. The cross section for $\pi^-\pi^-\pi^+\pi^+$ is found to be 3.6 mb. Abundant resonance production is observed, with fits indicating that quasi-two-body production constitutes approximately half the four-pion events. The model employed, which includes resonance production and Bose symmetrization, yields excellent fits to mass distributions and angular correlations. (auth)

22681 ELASTIC NEUTRON–PROTON CHARGE EXCHANGE SCATTERING BETWEEN 1.75 AND 7.20 GeV/c. Powell III, Smith Thompson. Ann Arbor, Mich.; Univ. of Michigan (1970). 122p. University Microfilms Order No. 71-4709.

Thesis.

The differential cross sections for neutron-proton elastic scattering in the charge exchange region were measured for incident neutron momenta between 1.75 GeV/c and 7.20 GeV/c. A neutron beam with a broad energy spectrum was produced by steering the external proton beam from the Bevatron onto a beryllium target. After collimation the neutrons were scattered off the protons in a liquid hydrogen target. The momenta of the forward-going protons were measured in a magnet and spark chamber system, while the much less energetic neutrons were detected by an array of thick scintillation counters. The detection efficiencies of the thick plastic scintillators were calculated. Several possible contaminating processes were investigated by Monte Carlo techniques, and were shown to be effectively eliminated by the cuts made on the data. The data indicate the existence of an energy dependent structure in the differential cross sections. (Diss. Abstr. Int., B)

22682 REACTION $pp \rightarrow pp\pi^+\pi^-$ AT 6.6 GeV/c. Colton, Eugene (Univ. of California, Los Angeles); Schlein, Peter E.; Gellert, Eugene; Smith, Gerald A. Phys. Rev., D; 3: 1063-88(1 Mar 1971).

A detailed analysis of 7514 $pp \rightarrow pp\pi^+\pi^-$ events at 6.6-GeV/c incident beam momentum is presented. Three types of analyses are presented which argue that a single-pion exchange process is responsible for the dominant peripheral $\Delta^{2+}p\pi^-$ production. An angular-correlation analysis is presented in which it appears that the 1450-MeV $\Delta\pi$ Deck enhancement is not a pure $J^P = \frac{1}{2}^+$ state. The demonstration that the absolute magnitude for this enhancement is accounted for by the pion-exchange process indicates that only one process (i.e., pion exchange with diffraction scattering at the π^-p vertex) contributes to the final state, and that a second process need not be added to the pion exchange to account for the observed cross section. Some ad hoc dependence on the $\Delta\pi$ mass must be introduced for a precise fit to the shape of the $\Delta\pi$ mass spectrum, or equivalently to the θ, ϕ angular distributions in the π^-p cm system. The $s_{\Delta\pi}^{2\alpha(t)}$ dependence of the Reggeized pion-exchange model of Berger is well known to accomplish this; however, the $\alpha(t)$ with unit slope required by this model is at variance with the apparently rather flat trajectory deduced from data on quasi-two-body pion-exchange-dominated reactions. It is suggested that a $\Delta\pi$ final-state-interaction model may be useful in understanding the reaction. (auth)

22683 PION PRODUCTION FROM BERYLLIUM AT 3^0 BY 12.3-GeV/c PROTONS. Marmer, G. J.; Lundquist, D. E. (Argonne National Lab., Ill.). Phys. Rev., D; 3: 1089-92(1 Mar 1971).

Absolute positive- and negative-pion production cross sections from a thin beryllium target were measured using a single-arm magnetic spectrometer. The scintillation counters were arranged in such a way that the solid angle of the system could be reliably calculated. Secondary beam intensities in the 1.0- to 5.0-GeV/c range can be calculated from these absolute cross sections. In addition, the well-known excess of π^+ over π^- production in the forward direction above 1.0 GeV/c is confirmed. (auth)

22684 SPARK CHAMBER MEASUREMENT OF THE Σ^+ LIFETIME. Keller, Lewis Porter. Stillwater, Okla.; Oklahoma State Univ. (1969). 87p. University Microfilms Order No. 70-21,423.

Thesis.

The decay rate of Σ^+ hyperons produced in the reaction $\pi^+ + p \rightarrow \Sigma^+ + K^+$ was measured using high precision wide gap spark chambers operated in the track mode. Using a π^+ beam from the Argonne ZGS, positive sigmas were produced in a hydrogen target and detected by requiring the charged particle from either $\Sigma^+ \rightarrow p\pi^0$ or $n\pi^+$ to be in coincidence with a delayed count in a stopping K^+ Cherenkov counter. The event geometry was reconstructed by projecting the K^+ and decay charged particle tracks back into the target region where there were no detectors. Ionization measurement of the wide gap tracks was used to distinguish the nonleptonic decay modes. The experimental result for the Σ^+ lifetime is $\tau_{\Sigma^+} = (0.70^{+0.11}_{-0.08}) \times 10^{-10}$ sec. In selecting sigma events it was found that measurements of the ionization ratio of the wide gap spark chamber tracks were within ±20% of the expected ionization ratio. (Diss. Abstr. Int., B)

22685 INVESTIGATION OF THE REACTION $\bar{p}n \rightarrow \pi^-\pi^-\pi^+\pi^0$ AT 3.5 GeV/c. Malko, John Anthony. Athens, Ohio; Ohio Univ. (1970). 185p. University Microfilms Order No. 71-4803.

Thesis.

The results of an experimental analysis of the reaction $\bar{p}n \rightarrow \pi^-\pi^-\pi^+\pi^0$ (1) using film obtained from an exposure of the MURA-Argonne 30" deuterium bubble chamber to a separated beam of 3.5-GeV/c antiprotons are presented. The results of this analysis are compared with the predictions of a modified statistical model, a cloud-core model and a quark model. With the upper limit of 8 centimeters for the projected length of the spectator proton, 65,076 frames of film were scanned and 12,690 acceptable events were found. Both events with and without a visible spectator were allowed. These events were then processed through film-plane measuring machines, with one remeasurement performed for failing events. The data reduction was carried out using the Berkeley

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chain of programs BRAVE–TVGP–SQUAW–SUMX(CERN version). The separation of hypotheses was performed by demanding 10% and 1% confidence levels for one-constraint and four-constraint hypotheses respectively, by putting a limit of ±0.12 GeV² on the missing mass squared for reaction (1) and by taking four-constraint hypotheses over one-constraint hypotheses in all cases. Where applicable, bubble density analysis was used to eliminate hypotheses. An upper limit of 200 MeV/c was put on the spectator momentum to help insure the applicability of the impulse approximation. Our final sample consisted of 441 events which unambiguously fit reaction (1). The events which were ambiguous between reaction (1) and one or more other one-constraint hypotheses numbered only 2% of the unambiguous sample. Also 66 events were separated out which fit the reaction $\bar{p}n \rightarrow \pi^-\pi^-\pi^+$ (2). Due to the small number of events, the analysis of reaction (2) was rather limited. A histogram of the laboratory momentum of the spectator protons from the events fitting reaction (1) showed a marked departure from the Hulthen prediction. This departure consisted of a shifting to lower momentum values for those events in which the spectator proton was not visible. It was found that reaction (1) is dominated by ρ-meson and f^0-meson production. No significant evidence is found for ω, A_2, or any other higher mass resonance. Also, double resonance channels are found to play an insignificant role. The branching ratios for reaction (1) are $\bar{p}n \rightarrow \rho^+\pi^-\pi^-$, (15 ± 3)%, $\bar{p}n \rightarrow \rho^-\pi^-\pi^+$, (24 ± 4)%, $\bar{p}n \rightarrow \rho^0\pi^-\pi^-$, (16 ± 4)%, and $\bar{p}n \rightarrow f^0\pi^-\pi^-$, (14 ± 4)%. A cross section of 0.64 ± 0.07 mb for reaction (1) and a cross section of 0.01 ± 0.02 for reaction (2) are found. The distribution of the cosine of the CMS polar angle for the pions from reaction (1), taking the z-axis to be along the direction of the incident antiproton, is plotted for each charge state of the pion. These distributions are found to be symmetric about a line perpendicular to the z-axis, as is required by GP-parity. When the effects of the resonances are included, the CMS momentum distributions for the pions from reaction (1) show good agreement with phase-space. There is no shifting to higher momenta, as is predicted by the Koba–Takeda theory. An analysis of the correlation-angle distribution of the pion pairs from reaction (1) indicates that the Bose–Einstein symmetrization effect does not play a significant part in the reaction. The statistical theory is found to be in general agreement with the experimental results, while the quark rearrangement model is found to be completely unreliable. (Diss. Abstr. Int., B)

22686 STUDY OF Σ^-P INELASTIC INTERACTION WITH Σ^- MOMENTUM FROM 0 TO 650 MeV/c. Stephen, David. Amherst, Mass.; Univ. of Massachusetts (1970). 186p. University Microfilms Order No. 71-2729.

Thesis.

The reaction $\Sigma^- + p \rightarrow \Lambda n$ and $\Sigma^-p \rightarrow \Sigma^0 + n$ were studied using 2402 visible polarized Σ^- produced by the reaction $K^- + p \rightarrow \Sigma^-\pi^+$ with the center of mass energy in the vicinity of the $Y_0^*(1520)$ resonance. The capture ratios for stopping and in-flight Σ^- were measured, and were all about 0.5. The cross sections were obtained for both reactions at Σ^- lab momenta from 1 to 650 MeV/c. The results indicated that in the Σ^- momentum ranges of 1 to 120 MeV/c the cross sections were much larger than the S-wave absorption limits, indicating a constructive interference between the Coulomb and nuclear interactions. The cross sections in the momentum range of 120 to 400 MeV/c followed very closely the S-wave absorption limits. The angular distributions showed definite nonisotropy in this region, indicating the presence of P and D waves. Two enhancements were found in the cross sections in the Σ^- momentum range of 400 and 650 MeV/c. They were observed at 2171 and 2191 MeV Σ^-p center of mass energies. Insufficient data prevented a Breit–Wigner fit to these enhancements. The polarization of the outgoing Λ was measured w.r.t. to the incoming Σ^- polarization direction. The stopping Σ^- results indicate strongly that the $^3S_1$ state dominated in the capture process. The polarization data for the in-flight reactions indicated that the Λ polarization varied rapidly with the Σ^- momentum and also exhibited a rotation of the polarization axis. The results of angular distribution and polarization seemed to indicate that the spin-orbit and spin-spin forces were present in addition to just central radial forces in the hyperon-nucleon forces. (Diss. Abstr. Int., B)

Strong (Meson-Induced)

22687 (COO–1428-255) EVIDENCE AGAINST AN $n\pi^-\pi^-$ ENHANCEMENT AT A MASS OF 1.627 GeV/c² IN $K^-d \rightarrow p_s\pi^+\pi^-\pi^-nK^0$ AT 4.48 GeV/c. Ammann, A. C.; Carmony, D. D.; Garfinkel, A. F.; Gutay, L. J.; Miller, D. H. (Purdue Univ., Lafayette, Ind. Dept. of Physics); Yen, W. L. (Indiana–Purdue Univ., Indianapolis. Dept. of Physics). [1970]. 5p. Dep. NTIS.

Recently evidence was presented for the production of an $n\pi^-\pi^-$ enhancement of mass 1627 MeV/c² in the reaction $K^-d \rightarrow p_s\pi^+\pi^-\pi^-nK^0$. With greater statistics, the data for the same reaction at nearly the same energy fail to show any evidence for such a resonance. (auth)

22688 (JEN–217-IFIC/I-4) DOUBLE EMISSION OF Λ HYPERONS IN THE K^- OF 6 GeV/c INTERACTIONS WITH NUCLEUS OF PHOTONUCLEAR EMULSION. Tejerina Garcia, A. F. (Junta de Energia Nuclear, Madrid (Spain)). 1970. 27p. Dep. NTIS (U.S. Sales Only).

In this memory one analyzes the interactions with three or more centers, produced by K^- of 6 GeV/c with nucleus of photonuclear emulsion. The analysis of one event with three centers was consistent with the formation and decay of double hyperfragment ${}_{\Lambda\Lambda}C^{11}$, the binding energy of the two Λ hyperons to the nuclear core of double hyperfragment is $B_{\Lambda\Lambda} = 20.2 \pm 1.1$ MeV and the $\Lambda-\Lambda$ interaction contribution to $B_{\Lambda\Lambda}$, $B_{\Lambda\Lambda} = 3.2 \pm 1.1$ MeV. Another event of three centers was analyzed as produced by the formation and decay of the cascade hyperfragment Ξ B^{11}, the binding energy of cascade hyperon is $B\,\Xi = 9.2 \pm 2.2$ MeV. (auth)

22689 (JINR–E2-5627) $X^0(960)$ MESON: 2^- OR 0^-. Ogievetskii, V. I.; Tybor, W.; Zaslavskii, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 9p. Dep. NTIS (U. S. Sales Only).

It is shown that the available experimental data are equally consistent with the spin-parity 0^- and 2^- of the X^0 (960) meson, 2^- seems to be somewhat preferable. Both spin-parity alternatives and new experiments to distinguish between them are discussed. (auth)

22690 (TID-25667) ABSORPTION AT REST AND LOW ENERGY ELASTIC SCATTERING OF K^- MESONS BY NEON. Moulder, Jerry W. (Tennessee Univ., Knoxville). Aug 1970. 91p. Dep. NTIS.

Thesis.

The BNL–Columbia bubble chamber filled with a 24 mole % mixture of neon and hydrogen, was exposed to a stopping K^- meson beam in order to study the interaction of K^- mesons with neon. On the basis of 1549 examples of K^- neon interactions at rest, the general systematics are presented and comparisons are made with other K^- nucleus interactions. Various final state interactions are investigated and shown to be significant. Approximately 55% of the sigma hyperons produced in primary processes, undergo a final state interaction with a nucleon, producing Λ^0 hyperons. The hyperfragment production rate is 10% and the nonmesic absorption rate 28% assuming no pion reabsorption. The hyperfragment production rate of Λ^0 hyperons produced by Σ hyperon conversion is estimated to be 14%, slightly higher than the overall hyperfragment production rate. The conversion rate of nonmesically produced sigma hyperons is higher than the conversion rate for mesically produced sigma hyperons. In addition the elastic scattering of K^- mesons by neon in the momentum range, 65 to 240 MeV/c is investigated. The angular distributions and the cross sections in three momentum intervals are presented. (auth)

22691 MEASUREMENT OF THE A_2^- MESON MASS SPECTRUM. Grayer, G. (CERN, Geneva); Hyams, B.; Jones, C.; (and others). Phys. Lett.; 34B: 333-6 (1 Mar 1971).

The reaction $\pi^-p \rightarrow K^-K_S^0p$ at 17.2 GeV/c is measured and some 1400 $A_2^- \rightarrow K^-K_S^0$ decays are observed with no evidence for a double mass peak. The mass resolution is ±5.7 MeV. The A_2 is produced in a nearly pure $|\,|,\ m> = |2,1> + |2,-1>$ state in the Gottfried–Jackson system. (auth)

22692 STUDY OF STRANGE-PARTICLE PRODUCTION FROM FOUR-PRONG π^+p INTERACTIONS AT 8 GeV/c. Balea, E.; Balea, O.; Mihul, A.; Sabau, M. (Inst. of Nuclear Physics, Bucharest). Stud. Cercet. Fiz.; 22: 1041-53(1970). (In Rumanian).

The experimental methods used in order to obtain the five- and six-body final states with strange particle production from π^+p interactions at 8 GeV/c are presented. Peyrou distributions are given and commented. (auth)

22693 STUDY OF THE DECAY $\Lambda(1520) \rightarrow \Sigma(1385)\pi$. Burkhardt, E. (Univ., Heidelberg); Filthuth, H.; Kluge, E.; (and others). Nucl. Phys.; B27: 64-72(1971).

An analysis was made of 548 events of the final state $\Lambda\pi^+\pi^-\pi^0$ in K^-p interactions at 777 to 1226 MeV/c, in search for the sequence $K^-p \rightarrow \Lambda(1520)\pi^0 \rightarrow \Sigma(1385)^\pm\pi^\mp\pi^0 \rightarrow \Lambda\pi^+\pi^-\pi^0$. Evidence was found for the existence of this decay from the invariant-mass distributions and angular distributions. Partial widths are calculated, and SU(3) implications are discussed. (L.B.S.)

22694 NATURE OF ENERGY-SELECTED PARTICLES IN INELASTIC INTERACTIONS. Gaitinov, A. Sh.; Takibaev, Zh. S.;

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Chasnikov, I. Ya. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 13: 124-9(Jan 1971). (In Russian).

Properties of the energy-selected particles (e.s.p.) in inelastic interactions of π^- mesons and protons are studied. It is shown that the parameters of e.s.p. from the 4-prong π^-p and pp interactions at ~10 GeV coincide with each other and differ from the parameters of other particles. Mean energies and transversal momenta of e.s.p. are different for different channels of reactions. It is established that e.s.p. are produced in most cases in ρ^0 resonance decay. The fraction of e.s. π^-, π^+, and π^0 mesons per one interaction is estimated. (auth)

22695 DECK EFFECT IN REACTION $\pi^-p \rightarrow \rho^0\pi^-p$ AT 4.45 GeV/c. Beketov, G. V.; Zombkovskii, S. M.; Kaidalov, A. B.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 104-12(Jan 1971). (In Russian).

The reaction $\pi^-p \rightarrow \rho^0\pi^-p$ at 4.45 GeV/c was studied using a 50-cm liquid-hydrogen bubble chamber. The effective mass distribution of the $\pi\rho$ system for events with $|t_\rho| < 0.5$ $(GeV/c)^2$ (t_ρ is the ρ 4-momentum transfer squared) has a maximum in the A_1-meson mass region and is in good agreement (in absolute values) with calculation results of the Regge π-pole exchange model. The effective mass distribution of the $\pi\rho$ system for events with $|t_\rho| > 0.5$ $(GeV/c)^2$ is satisfactorily described by the invariant phase space curve with the addition of the Breit–Wigner curve of A_2 meson. For events of reaction $\pi^-p \rightarrow \rho^0\pi^-p$ with $|t_\rho| < 0.5$ $(GeV/c)^2$ the angular distributions for the decay of the $\pi\rho$ system with the mass in the A_1-resonance region are in agreement with that expected for partial decay quantum numbers $J^P = 1^+$ and with the angular distributions calculated from the Regge π-pole exchange model. (auth)

22696 STUDY OF $\Sigma^\pm$ PRODUCTION FROM K^- + ^{4}He INTERACTIONS. Riley, Benny Rudolph. Pittsburgh; Carnegie-Mellon Univ. (1970). 193p. University Microfilms Order No. 71-4541.

Thesis.

A study of $\Sigma^\pm$ production from K^--^{4}He interactions was performed. The data were obtained from the ANL-CMU liquid helium bubble chamber that was exposed to a low-momentum K^- beam at Argonne National Laboratory in 1966. The data include interactions from in-flight K^--mesons as well as stopped K^--mesons (i.e., K^--mesic atoms are formed before nuclear capture). The $\Sigma^\pm\pi^{\mp3}$H final states were analyzed within the framework of the impulse approximation. Four variations of the $\bar{K}N \rightarrow Y\pi$ matrix element were used: (1) a constant, (2) a Breit–Wigner, (3) one obtained from the fitted $\bar{K}N$ parameters of Kim, and (4) one obtained from the fitted $\bar{K}N$ parameters of Martin and Sakitt. Matrix elements (3) and (4) predict a virtual bound state of the $\bar{K}N$ system usually interpreted as the $Y_0^*(1405)$. The in-flight data are not well represented when elements (1), (3), or (4) are used in the impulse model calculation, but the Breit–Wigner form with a mass of 1390 MeV/c^2 and a width of 50 MeV/c^2 does fit the data (^{3}H momentum spectrum) well. In addition to the $\bar{K}N \rightarrow Y\pi$ matrix element, the impulse model predictions for the stopping K^- interactions are shown to be sensitive to the orbital angular momentum capture state of the K^- and to the form of the ^{4}He wave function. A reliable estimate of the relative amounts of S, P, and D capture cannot be made because of the uncertainties in the $\bar{K}N \rightarrow Y\pi$ matrix below $\bar{K}N$ threshold and in the form of the ^{4}He wave function. But the data imply that most stopping K^--mesons are captured from S orbital angular momentum states. An upper limit of ~2% D-state capture is implied by the data. This disagrees with the model-dependent 7% D capture result from K^- x-ray data. The Σ^- cascade time in liquid ^{4}He (measured for the first time in this experiment to be $(3 \pm 1) \times 10^{-11}$ seconds) supports the trapping hypothesis. It is estimated that 11% of all events with a Σ^+ in the final state result from two-nucleon capture of the K^-, whereas 22% of all the events with a Σ^- in the final state result from two-nucleon capture. An enhancement in the Σ^- momentum spectrum (Σ^-ppn final state) at ~220 MeV/c appears to result from a two-step process: $K^- + {}^4He \rightarrow \Sigma^-\pi^{+3}H$; $\pi^+ + {}^3H \rightarrow$ ppn. (Diss. Abstr. Int., B)

22697 EXPERIMENTAL STUDY OF THE REACTIONS K^- + $p \rightarrow \pi^- + \Sigma^+$ AND $K^- + p \rightarrow \pi^- + Y_1^*$ (1385) AT 8 AND 16 GeV/c. Mucci, John Francis. Pittsburgh; Carnegie-Mellon Univ. (1970). 101p. University Microfilms Order No. 71-4539.

Thesis.

Using a high resolution, single-arm magnetic spectrometer on line to a computer, accurate differential cross sections for the processes $K^- + p \rightarrow \pi^- + \Sigma^+$ and $K^- + p \rightarrow \pi^- + Y_1^*$ (1385) were measured. The cross sections were measured at 8 and 16 GeV/c incident momenta and for small forward scattering angles (1 to 6° in the laboratory). The data show a smooth forward peak for the Σ reaction at both energies; the Y^* data have a much more shallow forward peak and give evidence of a turnover at very small angles (or small four-momentum transfer t) — these features are similar to those seen at lower energies. Total cross sections were calculated which show a slower energy dependence than predicted by lower energy data. Using the conventional Regge pole model, analyses were performed which indicate that this model of the processes is meaningful and that, under the assumption of the model, there are certain consistencies; for example, the Regge trajectories for the K*(890) and K**(1420) as calculated from Σ reactions and Y*(1385) reactions are the same within the errors. (Diss. Abstr. Int., B)

22698 MEASUREMENT OF THE REACTION $\pi^+ + p \rightarrow K^+ + \Sigma^+$ AT LARGE MOMENTUM TRANSFERS. Han, Ki Sup. Ann Arbor, Mich.; Univ. of Michigan (1970). 92p. University Microfilms Order No. 71-4623.

Thesis.

The differential cross section and polarization for the reaction $\pi^+ p \rightarrow K^+ \Sigma^+$ were measured for kaon laboratory angles between 13 and 27°. A missing-mass spectrometer composed of wire spark chambers detected the K^+ which was scattered in the forward direction and another set of wire spark chambers detected the proton which resulted from the decay $\Sigma^+ \rightarrow p\pi^0$. The spectrometer system was connected to an on-line computer. Approximately 1200, 1400 and 1000 events were obtained for incident pion momentum of 3, 4 and 5 GeV/c respectively. The results have been compared with the vector-tensor Regge pole exchange model of the hypercharge exchange reaction. Quantitative disagreements between the data and the prediction of the model were found at all energies. (Diss. Abstr. Int., B)

22699 $K^- + p \rightarrow K^0 + \Xi^0$ DIFFERENTIAL CROSS SECTION MEASUREMENT AT 1.8 GeV/c. Carlson, James Robert. Corvallis, Oreg.; Oregon State Univ. (1971). 105p. University Microfilms Order No. 71-5414.

Thesis.

The differential cross section for the reaction $k^- + p \rightarrow k^0 + \Xi^0$ was measured in a spark chamber experiment for an incident k^- momentum of 1.8 GeV/c. The target was liquid hydrogen confronted by an anti-coincidence counter to insure neutral particle production. A 60-element hodoscope signaled the presence of four charged particles in the final state. The angular distribution of the k^0 in the center of mass for 59 events was fit to a series of Legendre polynomials and a good fit was obtained using a maximum order of three. An examination of the fitted data reveals a peak in the backward direction, a dip in the forward direction, and some evidence for direct channel resonances. (Diss. Abstr. Int., B)

22700 K^+p ELASTIC SCATTERING AT 2.53, 2.76, AND 3.20 GeV/c. Whitmore, J.; Abrams, G. S.; Eisenstein, L.; (and others) (Univ. of Illinois, Urbana). Phys. Rev., D; 3: 1092-1105 (1 Mar 1971).

K^+p elastic scattering was studied at incident kaon momenta of 2.53, 2.76, and 3.20 GeV/c in the Argonne 30-in. hydrogen bubble chamber. Differential cross sections are presented for all scattering angles including the backward direction, where anomalous behavior was observed in the magnitude and slope of the backward peak in this momentum interval. The forward and backward peaks are compared with Regge models and with previously published data. Results are presented of a partial-wave analysis performed at 2.5 GeV/c. While the results are consistent with previous partial-wave analyses at lower energies, the data cannot establish the existence of a resonance in the K^+p system. (auth)

22701 STUDY OF THE NONIMPULSE EVENTS IN THE REACTIONS $K^-d \rightarrow \Lambda p$ AND $\Lambda\pi N$ AT 670 TO 925 MeV/c. Sims, W. H.; O'Neall, J. S.; Albright, J. R.; Brucker, E. B.; Lannutti, J. E. (Florida State Univ., Tallahassee). Phys. Rev., D; 3: 1162-4(1 Mar 1971).

The ΛN effective-mass spectrum gives confirming evidence for an enhancement near 2130 MeV/c^2 in the $\Lambda\pi^-p$, $\Lambda\pi^-\pi^0p$, and $\Lambda\pi^-\pi^+n$ channels. The interpretation of this ΛN enhancement as either a resonance or a final-state interaction, or a combination of both, is discussed. This effect, if interpreted as a resonance, has fitted mass and width of 2127 ± 1 MeV/c^2 and 8 ± 1 MeV/c^2, respectively. (auth)

22702 STRANGE PARTICLE PRODUCTION IN π^+p INTERACTIONS AT 8.5 GeV/c. Krebs, George Nicholas Jr. New Brunswick, N. J.; Rutgers–The State Univ. (1970). 130p. University Microfilms Order No. 71-3068.

Thesis.

Approximately 3000 two- and four-prong strange-particle events having at least one associated V^0 decay were analyzed. The data were from a 60,000 picture exposure of the Brookhaven National Laboratory 80-inch hydrogen bubble chamber to a beam of 8.5 GeV/c π^+ mesons. The cross sections for K^+K^0, $K^0\bar{K}^0$, $K^+\Lambda^0(\Sigma^0)$ and $K^0\Lambda^0(\Sigma^0)$ production were deduced from the numbers of events

with a single K^0_1, a single Λ^0, a $K^0_1\Lambda^0$ pair, and a $K^0_1K^0_1$ pair observed. No resonant structure was observed in the 72 events with an associated $\Lambda^0K^0_1$ pair nor in the 58 events with an associated $K^0_1K^0_1$ pair. The fitted V^0 parameters were combined with the reconstructed but unfitted charged track parameters to investigate resonance production. The $K^{*+}(890)$, $K^{*-}(890)$, and the $Y_1^{*+}(1385)$ resonances were abundantly produced. The fact that $Y_1^{*-}(1385)$ production was suppressed relative to that for $Y_1^{*+}(1385)$ was explained in terms of a one particle exchange model. Cross sections of between one and 100 microbarns were obtained for all final states resulting in a 2C or a 4C fit. In the two prong plus V^0 events the 1C fits for the final states with one missing neutral particle were sufficiently unreliable and ambiguous that only approximate cross sections were estimated. No 1C fits were attempted in the four-prong plus V^0 data. The most significant results of the experiment were the small values of the cross sections, the strong evidence favoring one-particle-exchange mechanisms, and the lack of strong evidence for any resonant structure except for the $K^{*\pm}(890)$, the $N^{*++}(1236)$, and the $Y_1^{*+}(1385)$. Some evidence was found, however, for $\varkappa^+(725)$ production in four prong plus K^0_1 events and for $Y^{*+}(1690)$, and $\rho^0(760)$ production. (Diss. Abstr. Int., B)

22703 Λp RESONANCE OBSERVED IN NUCLEAR EMULSION. Goyal, D. P. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 3: 1259-60(1 Mar 1971).

It is found that the reported enhancement in the Λp mass distribution at 2110 MeV in an emulsion experiment of Jain is probably due to experimental biases in the data. (auth)

22704 $K\bar{K}$ PRODUCTION IN FOUR-PRONG π^+p INTERACTIONS AT 8 GeV/c. Balea, E.; Balea, O.; Mihul, A.; Sabau, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 15: 1085-92(1970).

Results on five- and six-body final states with $K\bar{K}$ production in four-prong π^+p interactions at 8 GeV/c are presented. Cross sections for various channels are given. The kinematical behavior of secondary particles is discussed as well as the resonance production. (auth)

22705 Λ PRODUCTION IN FOUR-PRONG π^+p INTERACTIONS AT 8 GeV/c. Balea, E.; Balea, O.; Mihul, A.; Sabau, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 1021-8(1970).

Investigations on five- and six-particle final-states with ΛK production in π^+p interactions at 8 GeV/c are reported. C.m.s. momentum and angular distributions of secondary particles are discussed. Results on invariant mass distributions and the cross sections for resonance production are presented. (auth)

Particle Interactions and Properties (Theoretical)

General

22706 (DESY-70/67) HIGH-ENERGY POTENTIAL SCATTERING. [PART] II. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Dec 1970. Contract AT(30-1)-4101. 39p. Dep. NTIS.

In view of the advances of knowledge, both experimental and theoretical, about hadronic scattering processes at high energies, the potential-theory model studied before is found to exhibit a number of realistic features. Because partial differential equations can be dealt with in a much more straightforward manner than operator equations, this potential-theory model is useful in understanding some features of high-energy processes. The problem of exponentiation, i.e., the possible appearance of an exponential factor, is studied in detail. It is found that the simple-exponentiation form, found recently in field theories within certain approximations, does not hold in general when the scattering particles have a size or internal degrees of freedom. This result in turn is applied to the field-theoretical cases to further understand the nature of the approximations involved. (auth)

22707 (DESY-71/1) HIGH-ENERGY SCATTERING OF A FERMION WITH ANOMALOUS MAGNETIC MOMENT: NON-EXPONENTIATION. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan 1971. Contract AT(30-1)-4101. 9p. Dep. NTIS.

Although it is well-known that the scattering amplitude for a Dirac particle in a potential takes a simple-exponentiation form at high energies, it is shown that this is no longer the case, if the Dirac particle has an anomalous magnetic moment like the proton. This serves as an example of the conclusion that simple exponentiation holds only if a particle can be treated as a point with no internal structure or internal degrees of freedom. This means that simple exponentiation is unlikely to occur for high-energy amplitudes of hadron-hadron scattering. (auth)

22708 (IC-71/3) COMPUTATION OF RENORMALIZATION CONSTANTS. Salam, Abdus (International Centre for Theoretical Physics, Trieste (Italy)). 1971. 37p. (CONF-710106-3). Dep. NTIS (U. S. Sales Only).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

The lecture covers analytic regularization methods and their applicability to nonpolynomial Lagrangians, and the effects of including quantized tensor gravity with the electrodynamics of leptons, that is the finite and gauge-invariant computation of the electron self-charge and self-mass in the quantum version of curved space and time. Also discussed is the suggestion that f mesons couple to the hadronic stress tensor in the same manner as Einstein gravitons do to leptons and the possibility of using this nonpolynomiality to regularize renormalization constants in strong interaction physics. (J.F.P.)

22709 (INP-712(Vol.1)) PROCEEDINGS OF THE X CRACOW SCHOOL OF THEORETICAL PHYSICS. VOLUME I. SCATTERING OF COMPOSITE OBJECTS. (Institute of Nuclear Physics, Krakow (Poland)). Jun 1970. 176p. Dep. NTIS (U. S. Sales Only).

There were five lectures included. Separate abstracts were prepared for all lectures. (J.F.P.)

For abstracts of individual lectures see: 22668, 22725, 22726, 22761, and 22837.

22710 (ITF-70-80-E) ASYMPTOTICAL RELATIONS FOR THE AVERAGED AMPLITUDE WITH THE MOST GENERAL UNDERSTANDING OF MICROCAUSALITY AND WITH ITS VIOLATION. Lomsadze, Yu. M.; Sabad, E. P.; Rovt, A. E. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 18p. Dep. NTIS (U. S. Sales Only).

It is shown that if the averaged asymptotical amplitude $\tilde{T}_{av}(\mathfrak{Z}\mathfrak{C} + \omega')$, $\varphi_D(\mathfrak{Z}\mathfrak{C})$ exists at least for one averaging function $\varphi_D(\mathfrak{Z}\mathfrak{C})$ then it, by reason of the generalized microcausality principle, is a boundary value of the function satisfying all the conditions of the generalized maximum principle of Phragmen-Lindelof-Nevanlinna in the closed upper complex halfplane and, consequently, the asymptotical relations and the asymptotical equalities must hold true for it under the corresponding conditions on the ω' axis. Also the generalizations of some of the asymptotical equalities with the violation of microcausality were obtained by means of introducing the elementary length. (auth)

22711 (NP-18716) DUAL CURRENT AMPLITUDES WITH SPURIOUS STATES. Ademollo, M. (Florence Univ. (Italy). Istituto di Fisica Teorica. Istituto Nazionale di Fisica Nucleare, Florence (Italy)); Gomis, J. (Florence Univ. (Italy). Istituto di Fisica Teorica). Jan 1971. 44p. Dep. NTIS (U. S. Sales Only).

The possibility of constructing a model for current amplitudes satisfying: (i) planar duality, (ii) complete factorization; (iii) the divergence conditions of CVC and current algebra, and (iv) absence of unphysical singularities is analyzed. The consistency of the points (i), (ii) and (iii) requires the contribution of spurious states in the factorization of the two-current amplitudes. The point (iv) is related to the off-shell extrapolation of the amplitudes and also shows the necessity of spurious states. It is therefore suggested that spurious states must have a physical interpretation in terms of hadrons. Then a specific model is considered in detail for the vector current operator. The relevant current amplitudes are shown to have a good behavior in the limit of zero current momenta: the single-current amplitudes are dominated by the external line insertions and the two-current amplitudes satisfy the Ward-Takahashi divergence conditions. The two-current amplitudes, however, have a bad behavior for arbitrary momenta showing also a violation of CVC due to the presence of spurious pole contributions. (auth)

22712 (NYO-2262-TA-229) USE OF COLLINEAR AND DOUBLE O(2,1) VARIABLES FOR SINGLE PARTICLE SPECTRA. Tan, Chung-I (Brown Univ., Providence, R. I. Dept. of Physics). [1970]. 10p. Dep. NTIS.

Various different sets of variables used for single particle inclusive experiments are grouped into two general types. The first type specifies momenta in collinear frames; and the other, double O(2,1) variables, specifies momenta in the rest frame of the produced particle. Advantages of each set of variables are briefly

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mentioned. Useful relations, exact as well as asymptotic, between various sets are provided. (auth)

22713 (UCRL-72955) FINE STRUCTURE CONSTANT $\alpha = e^2/hc$ AS A UNIVERSAL SCALING FACTOR. MacGregor, Malcolm H. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Jan 1971. 6p. (CONF-710106-5). Dep. NTIS.

From Conference on Fundamental Interactions at High Energy; Coral Gables, Fla. (20 Jan 1971).

A phenomenological relation is established between the fine structure constant and leptonic and gravitational processes. (J.F.P.)

22714 ELEMENTARY PARTICLES AND TOPOLOGICAL CONCEPTS. Saleemi, B. A.; Rafique, M.; Saleem, M. (Univ. of Punjab, Lahore). Punjab Univ. J. Math.; 3: 45-7(Apr 1970).

A discussion is given on the use of topological concepts for the characterization of elementary particles. (J.F.P.)

22715 SYMMETRIES AND DYNAMICS IN HIGH ENERGY PHYSICS. Cunningham, John (University Coll. of North Wales, Bangor). Punjab Univ. J. Math.; 3: 17-27(Apr 1970).

The mathematics used in high-energy physics is reviewed. Symmetries, dynamics, crossing, and Regge behavior are covered. (J.F.P.)

22716 EXISTENCE OF TACHYONS. Glueck, M. (Univ., Hamburg). Nuovo Cim.; 1A: 467-74(1 Feb 1970).

Some dynamical properties of tachyons are investigated. It is concluded that tachyons do not interact with ordinary matter. (auth)

22717 DIMENSION OF HADRONIC INTERPOLATING FIELDS. Orzalesi, C. A. (New York Univ., N. Y.); Raskin, P. D. Lett. Nuovo Cim.; 1: 331-5(20 Feb 1971).

An attempt is made to give a formulation of a light-cone operator product expansion which does not necessarily rely on perturbative models. The arbitrariness in off-shell extrapolations of hadronic amplitudes is removed in a physically meaningful way, and it is discussed whether or not this expansion can determine the high-energy behavior of hadronic scattering amplitudes. This is done in order to provide a field-theoretic alternative to the Regge pole formalism. (J.F.P.)

22718 THEOREM ON INTUITIVE TESTS OF PARITY CONSERVATION VIA SPIN POLARIZATION PROCESSES. Saenger, Robert M. (Univ. of Minnesota, Minneapolis). Contract AT(11-11)-1764. Nucl. Phys., B26: 263-8(1971).

Working in the helicity formalism it is shown that if parity is violated in a nontrivial way by the amplitudes for a two-body scattering reaction; then at least one of the parity-violating polarization correlation measurements, $M^{-}_{\gamma\delta;\alpha\beta}(\theta)$, all of which would vanish in the case of parity conserving amplitudes, is nonvanishing. More precisely, it is proven that $\Sigma|M^{-}_{\gamma\delta;\alpha\beta}|^2 = 2|F_+|^2|F_-|^2$ where F_+ and F_- are the parts of the scattering helicity matrix which are even and odd under reflection and $\{M^{-}_{\gamma\delta;\alpha\beta}\}$ is the set of all parity violating correlations taken from an orthonormal basis for the initial and final density matrices. This type of result is more general than the specific case considered and applies, for example, to decay processes as well. (auth)

22719 MEROMORPHIC MATHEMATICALLY DUAL AMPLITUDES WITH FERMIONS. Venturi, G. (Cambridge Univ., Eng.). Nuovo Cim.; 1A: 759-76(21 Feb 1971).

A previously proposed meromorphic and mathematically dual representation for an amplitude involving fermions is generalized to the case of an arbitrary number of external particles. The properties of the generalization are discussed and it is shown how it can be employed in the construction of mathematically dual amplitudes for two fermions with many pions, and many-meson amplitudes in which the mesons are composed of positive-parity spin-one-half quarks. All the leading trajectories obtained are then free of ghosts and parity doubling. The explicit forms for the five-point amplitudes are given. The properties of the amplitudes obtained are discussed and possible further applications and generalizations are suggested. (auth)

22720 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 4, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 77p.

22721 LETNYAYA SHKOLA PO PROBLEMAM TEORII ELEMENTARNYKH CHASTITS, OTEPYA, AVGUST 1967. III CHAST' METODY VYCHISLENIYA. (Proceedings of the 1967 Summer School on Elementary Particle Physics, Held at Otepaa, Estonian SSR, August 1967. Volume 3. Methods of Calculation). Ainsaar, A. (ed.). Tartu; Institute of Physics and Astronomy, Academy of Sciences, Estonian SSR (1969). 115p.

Phase integrals for determining characteristic reactions, total cross sections, lifetime, correlations, and other features of the phenomenological theory of elementary particles with constant form-factors were studied. Various distributions of masses and momenta are discussed. Data on multiple phase integrals were applied to single-contour integrals in a complex plane and calculated by a modified method of steepest descents. Detailed description is given on the computation algorithms. Special studies carried out using Hankel function theory are described. (R.V.J.)

22722 HIGH ENERGY PHYSICS INDEX, VOLUME 9, NO. 3, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 69p.

22723 APPLICATION DES DISTRIBUTIONS A L'ETUDE DES PARTICULES ELEMENTAIRES EN MECANIQUE QUANTIQUE RELATIVISTE. (Application of Distributions to the Theory of Elementary Particles in Quantum Mechanics). Schwartz, Laurent. Paris; Gordon and Breach Science Publishers, Inc. (1969). 136p.

The problems treated are essentially problems of pure mathematics: the distribution theory with vector values; the tensor product of topological vector spaces; the Fourier transform and the Bochner theorem; the Hilbert subspaces and the associated kernels. (France)

Electromagnetic

Refer also to abstracts 22799 and 22874.

22724 (CONF-700948-1) CURRENT AMPLITUDES IN DUAL RESONANCE MODELS. Ademollo, M. (Florence Univ. (Italy). Istituto di Fisica Teorica. Istituto Nazionale di Fisica Nucleare, Florence (Italy)). Nov 1970. 26p. Dep. NTIS (U. S. Sales Only).

From Symposium on meson photo and electroproduction at low and intermediate energies; Bonn, Germany (21 Sept 1970).

An account of attempts to extend the dual resonance model to include the electromagnetic and weak interactions of hadrons is given. General properties of dual current amplitudes, phenomenological and factorizable models, are considered. (J.F.P.)

22725 (INP-712(Vol.1), pp 53-96) SCATTERING OF COMPOSITE PARTICLES AT VERY HIGH ENERGY WITH APPLICATIONS TO QUANTUM ELECTRODYNAMICAL PROCESSES. Czyz, Wieslaw (Institute of Nuclear Physics, Krakow (Poland)).

In Proceedings of the X Cracow School of Theoretical Physics. Volume I.

A simple well-known and naive model of high-energy multiple scattering at small angles is considered. Computations of Delbrueck scattering, and tests of the model developed are discussed. (J.F.P.)

22726 (INP-712(Vol.1), pp 97-106) SCATTERING OF PHOTONS AND ELECTRONS ON NUCLEI. Lohrmann, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)).

In Proceedings of the X Cracow School of Theoretical Physics. Volume I.

The lectures cover the scattering of photons on protons, ρ and ω photoproduction on heavy nuclei, and electron scattering by nuclei. (J.F.P.)

22727 (ITF-70-72) ELECTROPRODUCTION OF PSEUDOSCALAR MESONS AT HIGH ENERGIES. Kobylinskii, N. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

A consideration is made of the processes of electroproduction of pseudoscalar mesons on nucleons at high energies. The behavior of terms of the differential cross section in the model is investigated taking into account poles and cuts. A number of consequences of the vector dominance model is also obtained. (auth)

22728 REGGE ANALYSIS OF ELECTROPRODUCTION AND PHOTOPRODUCTION. Pagels, H. R. (Rockefeller Univ., New York). Phys. Lett.; 34B: 299-303(1 Mar 1971).

The analytic properties of the Regge residue functions are established in electroproduction, and it is hypothesized that all Regge poles have scaling behavior. The proton structure function is fitted with $F_2^p(\rho) = 0.11 + 0.48\ \rho^{-\frac{1}{2}}$, and using photoproduction data $F_2^p(\rho) - F_2^n(\rho) = 0.15\ \rho^{-\frac{1}{2}}$ for $\rho = \nu/-q^2 > 4$ is predicted. (auth)

22729 GAUGE CONDITION IN HELICITY FORMALISM. Ebata, Takeshi (Tohoku Univ., Sendai); Akiba, Tomoya; Lassila, Kenneth E. Progr. Theor. Phys. (Kyoto); 44: 1684-97(Dec 1970).

Through the example of boson Compton scattering, the gauge invariance requirement is formulated in the helicity formalism. The formalism assumes that the longitudinal helicity amplitudes vanish as powers of photon invariant "mass," and the virtual Compton scattering can be treated in a unified way with the real one. The formalism is used to discuss the problem of Born terms, Regge pole theory and other related topics. Since the formalism exploits only the knowledge of the crossing matrix, it should be applicable to more complicated reactions. (auth)

22730 VECTOR DOMINANCE MODEL AND THE P,P' AND A REGGE-POLE TRAJECTORY EFFECTS IN HIGH ENERGY COMPTON SCATTERING. Wada, W. (Ohio State Univ., Columbus). Phys. Lett.; 34B: 317-21(1 Mar 1971).

The forward Compton scattering is investigated assuming that the high energy scattering of the ρ^0, ω and Φ mesons is dominated by the exchanges of the P, P' and A trajectories. Reasonable agreement with experiment was obtained. (auth)

22731 ASYMPTOTIC BEHAVIOR OF ELECTROPRODUCTION AMPLITUDES IN LADDER MODELS. Sakai, Norisuke (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 44: 1643-53(Dec 1970).

Asymptotic behavior of single pion electroproduction amplitude is investigated using ladder models in the limit of s and k^2 tending to infinity. Two cases are considered which are referred to as the elementary and composite pion models. In the former, Born terms without k^2 dependence dominate the amplitude. In the latter, the amplitude exhibits Regge behavior with its residue function depending upon k^2, e.g., $(k^2)^{-2} \cdot (-s/k^2)^{\alpha(t)}$ when s grows faster than k^2, while it depends upon k^2 only but does not show any Regge-like behavior when k^2 grows faster than s. This fact leads us to the conclusion that there is a large kinematical region where Regge asymptotic behavior does not hold in electroproduction processes. This implies that a higher cutoff is needed to substitute the high energy side of the finite energy sum rule by Regge contributions when k^2 increases. In this connection, a suggestion is made on the modified duality between Regge residue functions and resonance excitation form factors instead of Harari's conjecture on the duality. (auth)

22732 HIGH-ENERGY DATA ON CHARGED-PION PHOTOPRODUCTION. Devenish, R. C. E.; Leigh, W. J.; Lyth, D. H. (Univ. of Lancaster, Eng.). Nuovo Cim.; 1A: 475-82(1 Feb 1970).

The data are examined on high-energy charged-pion photoproduction, for $0 < |t| < 0.5$ (GeV)^2 and for $7 < s < 35$ (GeV)^2. The observed large amount of isoscalar-isovector photon interference will violate a Pomeranchuk-type theorem unless it disappears with increasing energy. Resonance-saturated FESR's predict, in agreement with experiment, that the isovector amplitudes become dominant as $|t|$ decreases to zero. (auth)

22733 BJORKEN SCALING LIMIT IN FIELD-THEORY MODELS. Gaisser, T. K.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Nuovo Cim.; 1A: 501-22(1 Feb 1970).

The Bjorken scaling limit for deep inelastic electron-proton scattering is investigated in a field-theory model by methods previously used to discuss Regge properties and the Bjorken–Johnson–Low limit. In a cut-off theory the results are similar to those obtained by Drell, Levy and Yan in an analysis inspired by the parton picture, except that behavior of the structure functions in the large-ω limit is identified with properties of Regge poles in the t-channel. A theory with a neutral gluon is favored since it leads to R = 0. A new sum rule is derived. If third spectral-function effects are neglected this sum rule reduces to one satisfied in the Veneziano model of Landshoff and Polkinghorne. In a theory without a cut-off, scale invariance is violated by logarithmic terms arising from the same mechanisms which lead to similar violation of the Bjorken–Johnson–Low limit. The leading-order terms from convergent diagrams are summed and agree with a similar expression calculated by Chang and Fishbane. (auth)

22734 INCOHERENT PION PHOTOPRODUCTION FROM COMPLEX NUCLEI. Bertocchi, L. (International Centre for Theoretical Physics, Trieste, Italy. Univ., Trieste, Italy); Hoegaasen, H. Nuovo Cim.; 1A: 536-44(1 Feb 1970).

A violation of the vector-dominance model suggested by experimental data on photoproduction of pions with polarized photons on protons was included in the Gottfried–Yennie formulation of the theory of incoherent pion photoproduction in complex nuclei. An approximate calculation can explain the lack of energy dependence of the effective proton number Z_{eff} experimentally found between 8 and 16 GeV, and a variation with nuclear size of the asymmetry of production of pions with linearly polarized photons in complex nuclei is predicted. (auth)

22735 CONSTRUCTION OF PION PHOTOPRODUCTION AMPLITUDES FROM EXPERIMENTAL DATA. Alvarez-Estrada, R. F. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Sanchez-Gomez, J. L. Nucl. Phys., B26: 433-44(1971).

New formulas for constructing the pion photoproduction amplitude J from experimental data are presented. The phase of J is expressed in terms of its zeroes in the energy plane, the particle poles and a dispersion integral over the modulus of J, the latter being given, except for a finite unphysical interval, in terms of differential cross sections and recoil nucleon polarizations. For $\gamma p \to \pi^+ n$ at $t \approx -0.870\ \mu^2$, where the unphysical-region contribution vanishes, the zeroes are found approximately, so that the phase of J can be uniquely determined from the experimental data. (auth)

22736 PHOTOPRODUCTION, S-CHANNEL HELICITY CONSERVATION, AND REGGE CUTS IN THE T-CHANNEL. Gault, F. D. (Univ. of Durham, Eng.). J. Phys., A (London); 4: 38-43(Jan 1971).

Using covariant Regge couplings and invariant amplitudes for the process $\gamma N \to 0^- N$ the constraints imposed upon the t-channel helicity amplitudes by the hypothesis of s-channel helicity conservation were examined. Class III pion conspiracy is consistent with the hypothesis as are contributions from conspiring π, B and ρ, A_2 Pomeron cuts. Regge cut contributions arising from ω Pomeron exchange are forbidden to conspire. (auth) (UK)

22737 INELASTIC DIFFRACTIVE RHO PHOTOPRODUCTION AND COMPTON SCATTERING. Wolf, Guenter (DESY, Hamburg). Nucl. Phys., B26: 317-29(1971).

Inelastic diffractive ρ^0 photoproduction via diffractive ρ-isobar production and via double peripheral scattering was studied theoretically. The integrated cross section is found to rise slowly with energy, reaching $\approx 3\mu$b at 20 GeV and $\approx 4\ \mu$b at 100 GeV. The differential cross section $d\sigma/dt$ equals, in $\mu b/GeV^2$, $\approx 7 \exp(4t)$ at 5 GeV and $\approx 15 \exp(5.5t)$ at 10 GeV. The ρ-mass is predicted to be shifted in the same way as in $\gamma p \to \rho^0 p$. In addition a shift of the isobar mass should be observed. The same procedure was used to estimate the differential cross section for inelastic diffractive Compton scattering on protons; $d\sigma/dt$ comes out to be approximately energy independent for $E_\gamma > 5$ GeV and of the order of $0.2 \exp(6t)\ \mu b/GeV^2$. (auth)

22738 SCALE INVARIANCE AND EXTERNAL MASS DEPENDENCE OF REGGE RESIDUA IN A MULTI-VENEZIANO MODEL. Ramachandran, R. (Indian Inst. of Tech., Kanpur. Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., B26: 335-41(1971).

By factorizing a six-point Veneziano amplitude, the dependence of the Regge residue of a forward elastic scattering on the external masses is studied. It is found to have a $(q^2)^{-\alpha(0)}$ behavior. Such a dependence for space-like q^2 for the forward Compton amplitude would justify "scaling" in the Bjorken limit. (auth)

22739 P AND P' TRAJECTORY EXCHANGE MODEL FOR ELASTIC PHOTOPRODUCTION OF ρ^0-MESONS ON CARBON AT HIGH ENERGY. Rej, A. K. (Indian Statistical Inst., Calcutta). Lett. Nuovo Cim.; 1: 319-22(20 Feb 1971).

An analysis of an experimental study of the elastic photoproduction of neutral ρ mesons from carbon-12 at 8.8 GeV and small momentum transfer is given. The model used is based on the exchange of the P and P' trajectories. (J.F.P.)

22740 NOTE ON TESTS OF REGGE POLE-CUT MODELS. Mueller, H. J. W. (Univ., Munich). Lett. Nuovo Cim.; 1: 133-6(23 Jan 1971).

It is pointed out that careful measurements of the differential cross sections of charged pion photoproduction over a wide range of energies in the near-forward direction may be a crucial test of some cut models, if not also a test of the pion pole conspirator hypothesis. It is concluded that any rise of either cross section with increasing energy in the near-forward direction must be attributed to the presence of cuts. (J.F.P.)

22741 SEARCH FOR A LEFT–RIGHT ASYMMETRIC PHOTON POLARIZATION IN COMPTON SCATTERING BY POLARIZED ELECTRONS. Bock, P. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Lett. Nuovo Cim.; 1: 157-61(23 Jan 1971).

Experiments are described for separating higher-order polarization phenomena arising from single and double scattering processes in Compton scattering by polarized electrons. A mea-

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surement of the left–right asymmetry of unpolarized photons was made with an improved experimental arrangement which allowed a reduction of double scattering. Also a search was made for the left–right asymmetrical linear photon polarization after scattering by polarized electrons. It is found that the left–right asymmetry is less than $3(10)^{-4}$ in the angular range 30 to 90° for 412-keV photons, that the left–right asymmetric photon polarization is less than $3(10)^{-3}$ for scattering angles of 60 and 80°, and that the existence of higher-order polarization phenomena is confirmed. (J.F.P.)

22742 HARD-PHOTON EMISSION IN e^+e^- REACTIONS. Bonneau, G.; Martin, F. (Laboratoire de Physique Theorique et des Hautes Energies, Orsay, France). Nucl. Phys.; B27: 381-97(1971).

The radiative corrections to lowest order for the reactions e^+e^- giving any final state f, different from e^+e^-, are calculated, taking into account the contributions coming from the photons emitted by the electrons. Then an application of these results to the process $e^+e^- \rightarrow \pi^+\pi^-$ is done in the experimental conditions of ACO. The difference from: (i) a rigorous calculation of Feynman diagrams without using the "quasi-réel" process approximation, (ii) the error in the Coulomb terms, and (iii) a precise evaluation of the photon phase space. (auth)

22743 PHOTOPRODUCTION OF PIONS AND MASS DEPENDENCE OF AMPLITUDES. Eilam, G.; Berlad, G.; Dar, A. (Technion–Israel Inst. of Tech., Haifa). Nucl. Phys.; B27: 415-28(1971).

The validity of vector-meson dominance (VMD) relations for photoproduction of pseudoscalar mesons is tested in some well-defined calculable models. All models show that the production amplitudes of vector mesons transversely polarized in the s-channel helicity frame do not depend on the mass of the vector meson for large values of s, i.e. all models lead to the conclusion that the VMD relations for photoproduction should be postulated in the s-channel helicity frame. In particular this is true for the gauge invariant Born model incorporating exchange of particles with arbitrary spin and parity, and for the Van Hove model of reggeization, with or without absorption corrections. (auth)

22744 ANALYSIS OF HIGH-ENERGY CHARGED-PION PHOTOPRODUCTION FROM DEUTERIUM. I. Julius, David I. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B27: 269-84(1971).

The corrections to charged-pion photoproduction from deuterium due to two-step reactions are calculated from the Glauber model. The traditional assumption that the deuterium form factor varies rapidly in comparison with all reaction amplitudes is dropped in circumstances where, for this problem, it is manifestly untrue. The spin structure of the primary amplitudes is properly handled. Critical attention is paid to the role of inelastic intermediate states, the most important of which is the ρ^0NN channel, which is comparable in importance to the elastic πNN state. Assumptions made concerning the primary photoproduction amplitudes are extremely mild, and the results obtained are quite general, to be used in conjunction with any model for pion photoproduction for the purpose of extracting information about the amplitudes for a neutron target from the deuterium data. (auth)

22745 FASTER-THAN-LIGHT CHARGED PARTICLES. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; B27: 104-8(1971).

It is briefly shown that the problem of the electromagnetic field due to a charge moving since the infinite past with velocity greater than that of light, in empty space, may be reduced to that of a uniform infinitely-extended antenna; hence, the power spectrum is infinite. Next, it is shown that the rate of increase of energy of the electromagnetic field due to a pair of charged particles, one of which is moving with velocity greater than that of light, is also infinite. (auth)

22746 TADPOLE ELECTROMAGNETIC EFFECTS σ-COMMUTATOR TERMS AND η PCAC. Wallace, D. J. (Princeton Univ., N. J.). Contract AF49(638)-1545. Nucl. Phys.; B27: 221-36(1971).

A simple chiral model is studied for including the effects of σ-commutator terms in single-meson matrix elements of the conventional second-order electromagnetic Hamiltonian and it is concluded that they cannot be quantitatively identified with tadpole electromagnetic effects. In justifying the model, a new procedure is discussed for doing PCAC calculations with a pure octet η meson. The results of tadpole electromagnetic effects in $K \rightarrow 2\pi$ decays are illustrated in the appendix. (auth)

22747 DIFFRACTION-DISSOCIATION MODEL FOR HIGH-ENERGY RHO PHOTOPRODUCTION. Kramer, G. (Univ., Hamburg); Quinn, H. R. Nucl. Phys.; B27: 77-103(1971).

A model for two-pion photoproduction in the ρ-resonance region is constructed. The production proceeds by diffraction-dissociation of a photon into a pion pair which interacts strongly in the p-wave state. The effects of initial and final absorptive interaction with the proton are also included. Particular attention is paid to the invariant-mass spectrum of the dipion system. (auth)

22748 VARIATIONAL METHOD AND CHIRAL SYMMETRY MODEL. Okubo, S. (International Centre for Theoretical Physics, Trieste, Italy. Univ. of Rochester, N. Y.). Nuovo Cim.; 1A: 717-38(21 Feb 1971).

Some general consequences of the variational method were derived. In this way, one could justify the Reggeized tadpole model for electromagnetic-mass differences among hadrons. The result was especially applied to the chiral model of Gell-Mann, Oakes and Renner, and high-order effects of physical quantities with respect to the SW_3-violating parameters were computed. (auth)

22749 ALGORITHMS FOR ZERO-MOMENTUM VERTEX PARTS. Chisholm, J. S. R. (Univ. of Kent, Eng.). Nuovo Cim.; 1A: 77-82(21 Feb 1971).

Very simple algorithms are established which allow calculation of contributions to electromagnetic vertex part form factors in the limit of zero photon momentum, starting from any allowed combination of γ-matrices and traces. These algorithms are particularly useful when large numbers of terms are being evaluated with the help of a computer. (auth)

22750 INFLUENCE OF ANOMALOUS MAGNETIC AND (SUPPOSED) ELECTRIC MOMENTS ON FERMI-PARTICLE SPIN BEHAVIOR IN MAGNETIC FIELD. Loskutov, Yu. M.; Leventuev, V. P. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: 554-9(Sep-Oct 1970). (In Russian).

A solution was obtained for a normalized Dirac equation for a particle with abnormal magnetic and electric moments and found in a homogeneous magnetic field. The spin projection operators are taken and arbitrarily fixed in relation to the direction of the magnetic field and pulse axis. Precession of the spin appearing in the presence of particle anomalous magnetic and electric moments was also studied. (R.V.J.)

22751 POSSIBLE PRESENCE OF A SCALAR DIPION RESONANCE IN ρ-PHOTOPRODUCTION EXPERIMENTS. Greenhut, Gary K. (Northeastern Univ., Boston). Phys. Rev., D; 3: 1152-6 (1 Mar 1971).

The scalar resonance $\sigma(740)$ may be present in pion pair production experiments at nonforward angles in the region of the ρ. The consequences of this resonance in the cross section are examined in terms of the t dependence of the mass suppression factor in the ρ shape, $(m_\rho/m)^{n(t)}$, and the possibility of observing ρ–σ interference in the antisymmetric part of the cross section. (auth)

22752 CONTRIBUTION OF ELASTIC INTERMEDIATE STATES TO POLARIZATION OF THE RECOIL PROTON IN ELASTIC ELECTRON–PROTON SCATTERING. Hey, A. J. G. (Oxford Univ.). Phys. Rev., D; 3: 1252-8(1 Mar 1971).

The polarization of the recoil proton in the elastic scattering of unpolarized electrons and protons is calculated to order α^3, retaining only the elastic intermediate state in the unitarity sum that occurs. The result is therefore expected to correspond closely to the physical situation for electron laboratory energies up to the region where pion production becomes important. Using the "dipole fit" for the proton form factors G_E and G_M, the maximum value of the polarization is found to be ~0.03% for electron energies below 400 MeV. Above 10 GeV, the maximum elastic effect is ~1%. (auth)

22753 PHENOMENOLOGICAL PREDICTIONS FOR DEEP-INELASTIC ELECTRON SCATTERING. Ritson, D. M. (University Coll., London). Phys. Rev., D; 3: 1267-9(1 Mar 1971).

With preliminary information from colliding beams relative to the coupling of photons with "high-mass" hadron states, the 1960 Drell model for photons interacting with nucleons were extended to estimate off-the-mass-shell photon cross sections. Based on kinematic considerations of the domain in which the propagator of the virtual intermediate particle is large, cross sections and configurations for the final produced events can be predicted. (auth)

22754 PHOTONUCLEAR INTERACTIONS OF HIGH-ENERGY MUONS. Cassiday, G. L. (Univ. of Utah, Salt Lake City). Phys. Rev., D; 3: 1109-14(1 Mar 1971).

A calculation of the photonuclear energy-loss coefficient b_n is

made by extrapolating recent SLAC inelastic muon scattering data to the 10^{12}-eV energy region. Previous methods of calculation are discussed, and attention is drawn to the q^2 dependence of the inelastic cross section. It is also noted that b_n should be A dependent. This is predicted from vector dominance and indicated by the SLAC data on photoproduction off complex nuclei. The value of b_n obtained is 0.21×10^{-6} g^{-1} cm^2. The relationship of b_n to observed cosmic-ray muon intensities is discussed, along with the implications of higher b_n values than are predicted here. (auth)

22755 BREMSSTRAHLUNG, SYNCHROTRON RADIATION, AND COMPTON SCATTERING OF HIGH-ENERGY ELECTRONS TRAVERSING DILUTE GASES. Blumenthal, George R. (Univ. of California, San Diego, La Jolla); Gould, Robert J. Rev. Mod. Phys.; 42: 237-70(Apr 1970).

Expressions are derived for the total energy loss and photon-production spectrum by the processes of Compton scattering, bremsstrahlung, and synchrotron radiation from highly relativistic electrons. For Compton scattering, the general case, the Thomson limit, and the extreme Klein–Nishina limit are considered. Bremsstrahlung is treated for the cases where the electron is scattered by a pure Coulomb field and by an atom. For the latter case the effects of shielding are discussed extensively. The synchrotron spectrum is derived for an electron moving in a circular orbit perpendicular to the magnetic field and also for the general case where the electron's motion is helical. The total photon-production spectrum is derived for each process when there is a power-law distribution of electron energies. The problems of the effects of the three processes on the electron distribution itself are considered. It is shown that if the electron loses a small fraction of its energy in a single occurrence of a process, the electron distribution function satisfies a continuity equation which is a differential equation in energy space. For the more general case where the electron can lose energy in discrete amounts (as in bremsstrahlung and extreme Klein–Nishina Compton losses), the electron distribution function satisfies an integro-differential equation. Some approximate solutions to this equation are derived for certain special cases. (auth)

22756 EFFECTIVE RANGE FORMULA FOR VENEZIANO-LIKE PION FORM FACTOR. Ghika, G.; Visinescu, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 1079-84(1970).

Effective range corrections to the Veneziano-like pion electromagnetic form factor imposing elastic unitarity and constraints from current algebra are obtained. The theoretical predictions are compared with the experimental data. (auth)

22757 RADIATIVE CORRECTIONS TO DECAYS WITH A DALITZ PAIR. Lautrup, B. E. (CERN, Geneva); Smith, J. Phys. Rev., D; 3: 1122-35(1 Mar 1971).

The radiative corrections to the process $A \to B\gamma \to Be^+e^-$ (where A and B are hadrons) can be separated into a part which is purely dependent upon quantum electrodynamics (the one-photon-exchange diagrams) and a part dependent upon the hadronic structure (the two-photon-exchange diagrams). Neglecting the latter because such graphs are not singular when the lepton mass is set equal to zero, attention is given to the one-photon-exchange terms, and both the radiative corrections to the total decay rate including hard photons and the radiative corrections to the differential decay rate in the soft-photon approximation are calculated. The results are directly applicable to the decay $\pi^0 \to e^+e^-\gamma$, where our assumption that the two-photon-exchange graphs can be neglected is justified because $\pi^0 \not\to 3\gamma$ and the amplitude for $\pi^0 \to 2\gamma \to e^+e^-\gamma$ is proportional to the lepton mass. (auth)

22758 ELECTROPRODUCTION AND PHOTOPRODUCTION: SOME GROSS CHARACTERISTICS AT EXTREME ENERGIES. Das, T. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 3: 1136-9(1 Mar 1971).

Certain gross characteristics of inelastic lepton-hadron and photon-hadron collisions at extreme energies are correlated and discussed. It is argued that the total inelastic electron-proton cross section, for example, increases like $\ln^2 E$ as $E \to \infty$, where E is the incident electron energy, if the total photoabsorption cross section tends to a nonzero limit at high energies. The behavior of partial cross sections and average multiplicities for a given secondary at extreme energies for the two kinds of processes are also discussed. In particular, it is shown that if the behavior of the average multiplicity of any given hadron with respect to the incident energy is the same in electroproduction and photoproduction processes, it could only be logarithmic (or powers thereof). Implications of the various results in the context of certain existing models are also discussed. (auth)

22759 DIRECT-CHANNEL RESONANCE MODEL OF DEEP-INELASTIC ELECTRON SCATTERING. I. SCATTERING ON UNPOLARIZED TARGETS. Domokos, G.; Kovesi-Domokos, S.; Schonberg, E. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-4076. Phys. Rev., D; 3: 1184-90(1 Mar 1971).

A resonance model of deep-inelastic electron scattering is constructed. Using semiempirical rules for the form of the nucleon spectrum and a universality hypothesis for the transition form factors, explicit expressions are obtained for the structure functions W_1 and W_2 in the Bjorken limit. The ratio of the longitudinal to transverse photoabsorption cross sections vanishes for large momentum transfers, and νW_2 becomes scale invariant. A one-parameter fit is obtained to νW_2 (proton), and a zero-parameter prediction is made of νW_2 (proton-νW_2 (neutron). There is good agreement between the theory and experiment in the region where scale invariance is well established. (auth)

22760 DIRECT-CHANNEL RESONANCE MODEL OF DEEP-INELASTIC ELECTRON SCATTERING. II. SPIN DEPENDENCE OF THE CROSS SECTION. Domokos, G.; Kovesi-Domokos, S.; Schonberg, E. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-4076. Phys. Rev., D; 3: 1191-5(1 Mar 1971).

The spin dependence of the cross section of deep-inelastic electron (muon) scattering is investigated in the framework of the direct-channel resonance model. The structure functions entering the spin-dependent part of the cross section obey the following scaling laws in the Bjorken limit: νW_3 is a function of ω, and $\nu W_4 = W_3$. The polarization asymmetry is calculated in the framework of a quark model with orbital excitations; sizable asymmetries are predicted. The spin-dependent part of the cross section is found to be strongly model dependent; therefore, polarized-beam–polarized-target experiments should be able to distinguish between various models. (auth)

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22761 (INP-712(Vol.1), pp 1-52) LEPTON–HADRON PROCESSES AT HIGH ENERGY. Bjorken, J. D. (Stanford Linear Accelerator Center, Calif.).

In Proceedings of the X Cracow School of Theoretical Physics. Volume I.

The interactions $e + N \to e +$ hadrons, $\mu + N \to \mu +$ hadrons, $\nu + N \to \mu^- +$ hadrons, and $\bar{\nu} + N \to \mu^+ +$ hadrons are mainly considered. A review of the kinematical description and state of the data, current commutators and light cone behavior, dynamical models, and quantum electrodynamics at infinite momentum are treated. (J.F.P.)

22762 COMMENT ON PARITY VIOLATING NONLEPTONIC HYPERON DECAYS. Konno, Kimiaki; Nakamura, Katsuya (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 44: 1707-9(Dec 1970).

The parity-violating nonleptonic hyperon decays are discussed on the assumption of the absence rule in the t channel and under a restriction on a form of an effective Hamiltonian for all possible SU(3) spurions, 8, 10, 10^*, and 27. It is found that the characteristics of these amplitudes can be derived from the assumption of the 10, 10^*, and 27 absence in the t channel and the effective Hamiltonian for the current × current type. By using the usual baryon and meson 3×3 matrix field operators the Hamiltonian is expressed explicitly with two unknown coupling constants. (J.F.P.)

22763 SURVEY OF THE $\Delta I = \frac{1}{2}$ RULE IN $K \to 3\pi$ DECAY. Kellett, B. H. (Univ. of Manchester, Eng.). Nucl. Phys., B26: 237-44(1971).

The current experimental results on $K \to 3\pi$ are reviewed, and an independent analysis in terms of the $\Delta I = \frac{1}{2}$ rule is presented. Although the picture is incomplete, there is some evidence for a 5–10% admixture of $\Delta I = \frac{3}{2}$ in the weak Hamiltonian governing the decays. (auth)

22764 SELF-MASS CORRECTIONS AND THE CABIBBO ANGLE. Szymacha, A.; Tatur, S. (Univ. of Warsaw). Nuovo Cim.; 1A: 496-500(1 Feb 1970).

The value of the Cabibbo angle $\sin\theta = 0.33$ is obtained from the condition that the divergent parts of the electromagnetic and weak corrections to the hadron masses cancel. (auth)

22765 REGGE MODEL FOR INELASTIC LEPTON–NUCLEON SCATTERING. Pagels, Heinz (Rockefeller Univ., New York). Contract AT(30-1)-4204. Phys. Rev., D; 3: 1217-21(1 Mar 1971).

Lepton-nucleon scattering into hadrons is analyzed according to the simple Regge-pole model. Assuming SU(3) for the factorized residues, a strong-interaction analysis of tensor meson-

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baryon couplings yields $\sigma_T^{\gamma p}(\nu) - \sigma_T^{\gamma n}(\nu)/\sigma_T^{\gamma p}(\nu) - \sigma_T^{\gamma p}(\infty) = (0.26 \pm 0.05)$, to be compared with 0.31 obtained from the total photon-nucleon photoproduction data. For the inelastic structure functions, assuming all Regge poles couple in the deep-inelastic region, ${}^{\gamma}F_2^p(\rho) - {}^{\gamma}F_2^n(\rho) = +0.15\bar{\rho}^{-\frac{1}{2}}$, $\rho = -\nu/q^2 > 4$ is found. In the analogous neutrino process ${}^{\nu}F_2^p(\rho) + {}^{\nu}F_2^n(\rho) \simeq 0.66 + (3.5 \pm 1.7)\rho^{-\frac{1}{2}}$, $\rho > 4$ is established. Analyzing the Adler and Gross–Llewellyn Smith sum rules, the estimates ${}^{\bar{\nu}}F_2^p(\rho) - {}^{\nu}F_2^p(\rho) \simeq 1.5\rho^{-\frac{1}{2}}$, ${}^{\nu}F_3^n(\rho) + {}^{\nu}F_3^p(\rho) \simeq -8.9\frac{3}{\rho}$, $\rho > 4$ are obtained. It is also concluded that if scaling behavior of the neutrino process occurs for $-q^2 > 1$ GeV^2 then these sum rules are saturated to 90% only for energies $\nu > 200$ GeV for $-q^2 > 1$ GeV^2. (auth)

22766 ASYMPTOTIC BEHAVIOR OF WEAK SPECTRAL FUNCTIONS AND HADRONIC DECAYS OF THE W BOSON. Li, Ling-fong; Paschos, E. A. (Rockefeller Univ., New York). Contract AT(30-1)-4204. Phys. Rev., D; 3: 1178-84(1 Mar 1971).

Models of current algebra are employed to study the asymptotic properties of the spectral functions of weak currents. Asymptotically it is found that they all approach constant values closely related to each other. As an application, the results are used to estimate the hadronic decay of the intermediate vector boson. The branching ratio of the W decay into hadrons to the decay into leptons is of order unity, provided that the electron-positron annihilation total cross section is pointlike and predominantly isovector in character. Another contribution is a consequence of partial conservation of axial-vector current, which relates the decay rate of the W boson into a soft pion plus any number of bosons to the decay into all bosons through a known constant independent of the W mass. (auth)

22767 HYPERON BETA DECAY. Frampton, Paul H. (Univ. of Chicago. CERN, Geneva); Tung, Wu-ki. Phys. Rev., D; 3: 1114-21(1 Mar 1971).

Polarized-hyperon β decay is considered in the center-of-mass frame of the outgoing leptons. Simple and exact expressions are obtained for the differential intensity distribution function under the assumption of local current-current interaction and two-component neutrinos. It is shown that by exploiting only the fully integrated data, it is possible to make a large number of tests on the structure of the $\Delta S = 1$ current even with somewhat limited statistics. These include direct tests on the locality and V – A nature of the interaction without additional assumptions, as well as detailed and rather stringent tests on the Cabibbo theory. (auth)

22768 ISOSPIN STRUCTURE OF THE NONLEPTONIC WEAK HAMILTONIAN. Albright, C. H. (Ames Lab., Iowa); Oakes, R. J. Phys. Rev., D; 3: 1270-1(1 Mar 1971).

The isospin structure of the nonleptonic weak Hamiltonian is investigated under the assumption that the interaction can be constructed from the products of charged and neutral V – A octet currents. It is shown that quite generally, in addition to the well-known $\Delta S = \pm 1$, $\Delta I = \frac{1}{2}$ selection rule, a pure $\Delta S = 0$, $\Delta I = 0$ selection rule can be obtained. However, if charged currents, e.g., the Cabibbo current, occur in the interaction, then neither a pure $\Delta S = 0$, $\Delta I = 1$ nor a pure $\Delta S = 0$, $\Delta I = 2$ selection rule is possible. The implications for parity-violating effects in strangeness-conserving nuclear processes are discussed. (auth)

22769 REMARK ON THE WEAK ISOSPIN MODEL. Sohn, Ki Soo; Cho, Byung Ha. Kyungpook, South Korea; Kyungpook Univ. (1969). 5p.

Thesis.

By the observation of the decay mode satisfying $\Delta S = \Delta Q$ which shows the relation between the change of strangeness, ΔS, and that of charge, ΔQ, then the generality of $\Delta S = \Delta Q$ has been diminished. Under the assumption of the conservation of the weak isospin I' and its third component I'_3 in the weak interaction, the weak isospin model was proposed which is related to the charge Q and weak isospin I' by $Q = \frac{1}{2}Y' + I'_3$. Comparing with experimental data, the decay modes which could be described and could not be described by this isospin model are specified and checked. (Korean Sci. Abstr.)

22770 FOUR SU(2) INVARIANT WEAK INTERACTION MODELS WITH AN EXACT $|\Delta T| = 1/2$ RULE AND CP VIOLATION. Liu, Shu-ping. University Park, N. Mex.; New Mexico State Univ. (1970). 73p. University Microfilms Order No. 71-2871.

Thesis.

Four models of the effective weak interaction Hamiltonian and their mutual variations for incorporating the observed CP violation in the case of strangeness-nonconserving decays are presented. They are of locally coupled current-current form, involving all the hadron and lepton V–A currents known in particle physics. Each one of them unifies leptonics and nonleptonics, possesses an SU(2) symmetry and a certain universality, and gives the usual $|\Delta S| \leq 1$ rule and an exact $|\Delta T| = 1/2$ rule for $|\Delta S| = 1$ decays. The only parameters involved are a universal coupling constant and an angle of rotation, except for the CP-violating versions in which one more angle of rotation is necessary. The first angle fixes the relative weight between $\Delta S = 0$ and $|\Delta S| = 1$ leptonic decays. The second angle fixes the magnitudes of both the leptonic and nonleptonic CP-violating amplitudes. In two of the models, the Cabibbo universality is generalized. These two models contain the Cabibbo theory of leptonics, but with additional terms involving neutral currents only. These terms do not lead to the unwanted $K_L \rightarrow$ [charged-lepton pair] decays. In the other two models, a third lepton is postulated to be associated with each neutrino-charged lepton doublet. The third leptons are assumed to be more massive than kaons. A nonet of lepton currents is generated, and the total weak current is formed as the sum of the lepton current nonet and the unrotated hadron current nonet. This expresses a universality different from that of Cabibbo. All these models are consistent with the well-established experimental results. Tests for their respective predictions are discussed. The origin of the observed $|\Delta T| = 3/2$ nonleptonic decay $K^+ \rightarrow \pi^+\pi^0$ is attributed to the intervention of a nonelectromagnetic isospin-breaking term in the medium strong interaction, which gives the branching ratio $\Gamma(\Delta T = 3/2)/\Gamma(\Delta T = 1/2)$ with the correct order of magnitude compared with the observed value $\Gamma(K^+ \rightarrow \pi^+\pi^0)/\Gamma(K_S \rightarrow \pi^+\pi^0) \simeq 1/500$. Yet, the possibility of $K^+ \rightarrow \pi^+\pi^0$ being a purely weak process is also considered. In such a case, a coupling strength of about $G/(25\sqrt{2})$ is needed for the $|\Delta T| = 3/2$ transition term in the weak Hamiltonian. Varying the first two models to allow a $|\Delta T| = 3/2$ term also gives a term with $|\Delta S| = 2$ of nearly the same order of magnitude in coupling strength. Using this $|\Delta S| = 2$ transition operator and employing the stochastic quantum field theory, calculations for the mass difference of neutral kaons give results much too large compared with the experimental result. The models for semiweak interactions corresponding to the proposed models of weak interactions are also given. The intermediate vector bosons involved assume one of the following forms: a nonet, an incomplete monet with one component missing, or a vector in the four-dimensional internal space with a Lorentz-type indefinite metric. (Diss. Abstr. Int., B)

22771 THEORIES OF WEAK INTERACTIONS AND ASTROPHYSICAL EVIDENCE. Bandyopadhyay, P. (Indian Statistical Inst., Calcutta). Nuovo Cim.; 1A: 680-90(21 Feb 1971).

It has been proposed earlier that photons can interact weakly with neutrinos. Assuming this photon-neutrino coupling, the effect of energy loss due to the pair-annihilation process and the photo-neutrino process on the evolutionary time scales of a 15.6 $M_\odot$ star was discussed. In the typical model of Hayashi, Hoshi and Sugimoto (HHS), the lifetimes for carbon burning and later phases were calculated assuming the photon-neutrino coupling, and is compared with the results obtained by HHS according to the $(e\nu)(e\nu)$ coupling. In case of the $\gamma\nu\bar{\nu}$ coupling, the ratio of the number of blue supergiants (He-burning stars) to red supergiants (stars in C-burning and later stages) is found to be $\lesssim 10$ with the initial concentration of carbon $X_c = 0.5$, whereas according to the $(e\nu)(e\nu)$ coupling, the corresponding ratio is found to be nearly 33. According to astrophysical observations, this ratio is found to be nearly unity within a factor 1.5. It is noted that the result according to the $\gamma\nu\bar{\nu}$ coupling becomes significantly better in comparison with the $(e\nu)(e\nu)$ coupling. Also, in view of the uncertainties regarding the total luminosity in the red-supergiant phase as well as the rate of C + C relation, one can consider the result obtained according to the $\gamma\nu\bar{\nu}$ coupling to be in reasonable proximity to the "observed" value. From this, it is argued that stars seem to "favor" the photon-neutrino coupling theory rather than the current-current coupling theory of weak interactions. (auth)

22772 RADIATIVE CORRECTIONS TO THE MUON DECAY AND THE ANALYTIC REGULARIZATION METHOD. Girotti, Horacio Oscar (Facultad de Ciencias Exactas, La Plata). Nucl. Phys.; B27: 327-37(1971).

The analytic behavior of the amplitude corresponding to the reaction $\mu \rightarrow e\nu\bar{\nu}$ was analyzed with second-order electromagnetic radiative corrections as a function of the complex parameters characteristic of the analytic regularization methods. The amplitude is regularized first, as it is indicated by Bollini, Giambiagi and Gonzalez Dominguez and second following the more elaborated method given by Speer. The finite part of the amplitude obtained with each of the above mentioned methods is the same and agrees with the result given for it by Behrends, Finkelstein and Sirlin using the cut off method. However, the method I, when applied to the complete amplitude and not to each particular Feynman diagram, gives an analytic function of the complex parameter which

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is regular at the physical point, whereas with the Speer's method an undetermined constant appears in the final result which has to be absorbed by weak coupling constant renormalization. This last result contradicts the one given in III. The method I has not been extended for higher orders of perturbation theory whereas the Speer's method is quite general and gives a well defined prescription to regularize any Feynman diagram. Then it seems to us that the Speer's method of analytic regularization should be complemented in some way in order to take into account those cases in which the singularities of all Feynman diagrams, corresponding to a given order perturbation theory, cancel out exactly among themselves giving, in that order of perturbation, a regular amplitude. (auth)

22773 RENORMALIZABLE THEORY OF WEAK INTERACTIONS WITH A SINGLE MASSIVE SPIN-ZERO CHARGED BOSON AND NEUTRAL PSEUDOSCALAR HADRONS AS INTERMEDIATE BOSONS. Gupta, V. (Tata Inst. of Fundamental Research, Bombay); Patil, S. H. Nucl. Phys.; B27: 398-407 (1971).

A renormalizable theory of weak interactions with a single spin-zero charged massive intermediate boson $W^{\pm}$ and two charged massive leptons, $L_e^{\pm}$, $L_\mu^{\pm}$ is presented. The neutral intermediate boson is taken to be a combination of the usual pseudoscalar hadrons π^0, η^0 and X^0. The charged boson couples with unequal strengths to the leptons and octet hadron currents. A universality criterion is presented. It is shown that such a theory is consistent with all the present data if the mass of $W^{\pm}$ lies between few GeV and 20 GeV. Finally, some tests of the theory are suggested. (auth)

22774 NOTE ON THE K_{l3} SCALAR FORM FACTOR. Kamal, A. N.; Gourishankar, Radha (Univ. of Alberta, Edmonton). Lett. Nuovo Cim.; 1: 285-9(13 Feb 1971).

The scalar form factor $f_0(t)$ for three-body leptonic K decay is defined, and the parameter $\xi(t) = f_-(t)/f_+(t) = \xi(0) + \Delta t/m^2$ is discussed. The value of ξ at $t = 0$ is $\xi(0) = (M^2 - m^2)/m^2 (\lambda_0 - \lambda_+)$. For this relation the problem of a negative value of λ_0 is discussed. This negative value is explained using a model in which in the unitarity relation for the form factor only the πK intermediate state is retained, but the full $I = \frac{1}{2}$, $L = 0$ πK scattering amplitude which incorporates inelasticity is used. (J.F.P.)

22775 DEEP INELASTIC NEUTRINO SCATTERING. Grosse, H. (Univ., Vienna). Lett. Nuovo Cim.; 1: 261-6(13 Feb 1971).

The discussion of deep inelastic neutrino scattering covers the extended kinematics, the scaling limit, and numerical estimates. The interactions $\nu + N$ and $\bar{\nu} + N$ are studied. (J.F.P.)

22776 MORE ABOUT THE APPLICATION OF CURRENT ALGEBRA AND GAUGE INVARIANCE TO RADIATIVE WEAK DECAYS OF HYPERONS. Heiko, L. (Univ. Nacional Autonoma de Mexico, Mexico City. Ciudad Univ., Mexico City); Pestieau, J. Lett. Nuovo Cim.; 1: 347-50(27 Feb 1971).

The role of the soft-pion technique used in the radiative weak decays of hyperons is re-examined in conjunction with the soft photon theorem of Low. It is found that there is no resulting asymmetry. The conclusions are obtained independently of the type of couplings between baryons and mesons but are consequences of gauge invariance alone. The decay $\Sigma^+ \to p + \gamma$ is considered. (J.F.P.)

Strong (General)

22777 (ORNL-TM-3319) MONTE CARLO CALCULATIONS OF HIGH-ENERGY NUCLEON–MESON CASCADES AND APPLICATIONS TO GALACTIC COSMIC-RAY TRANSPORT. Armstrong, T. W.; Alsmiller, R. G. Jr.; Chandler, K. C. (Oak Ridge National Lab., Tenn.). 22 Feb 1971. 13p. (CONF-710304-2). Dep. NTIS.

From Symposium on Natural and Manmade Radiation in Space, Las Vegas, Nev.

Results obtained using a recently developed calculational method for determining the nucleon-meson cascade induced in thick materials by high-energy nucleons and charged pions are presented. The calculational method uses the intranuclear-cascade-evaporation model to treat nonelastic collisions by particles with energies $\gtrsim 3$ GeV and an extrapolation model at higher energies. The following configurations are considered: 19.2-GeV/c protons incident on iron, 30.3-GeV/c protons incident on iron, solar and galactic protons incident on the moon, and galactic protons incident on tissue. For the first three configurations, experimental results are available and comparisons between the experimental and calculated results are given. (auth)

22778 (SU-1206-239) FIXED POLE MODELS FOR THE POMERANCHUKON. Amann, R. F. (Syracuse Univ., N. Y. Dept. of Physics). Nov 1970. 13p. (NYO-3399-239). Dep. NTIS.

Fixed pole models, made consistent with crossed channel unitarity by the addition of a shielding cut, are shown to factorize and, therefore, to be an eligible model for the Pomeranchukon. Their phenomenological implications are explored; and, if the branch point of the shielding cut becomes complex, the combined pole plus cut entity is shown to provide an acceptable explanation of the Serpuchov data. (auth)

22779 SIMPLE TWO-CHANNEL DIFFRACTION MODEL FOR ELASTIC SCATTERING OF HADRONS AT HIGH ENERGIES. Kawasaki, Mamoru (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 44: 1618-32(Dec 1970).

A simple two-channel diffraction model for high-energy scattering of hadrons is given. In this model an inelastic channel representing the whole effects of inelastic processes is introduced as well as the elastic channel. The hadrons are treated as spinless particles. It is shown that if the vector- and scalar-type exchanges with strong t'-dependent amplitudes $\{\infty[\Lambda^2/(\Lambda^2 - t')]^n$, $n = 4$, $\Lambda^2 \simeq 0.3 \sim 0.4$ $(\text{GeV})^2\}$, are assumed for the inelastic channel, the present model gives results consistent with experiment for the energy dependence of the total cross sections and the forward slopes of the elastic differential cross sections. (auth)

22780 EXTENDED PARTICLE MODEL BASED ON THE QUARK MODEL WITH AN ARBITRARY NUMBER OF QUARK–ANTI-QUARK PAIRS. Fujimura, Kimio (Waseda Univ., Tokyo); Kobayashi, Tsunehiro. Progr. Theor. Phys. (Kyoto); 44: 1633-42(Dec 1970).

A model is proposed where an arbitrary number of internal oscillator freedom is introduced by describing the hadrons as extended particles with an arbitrary number of the quark–anti-quark pairs. The model is applied to the electromagnetic form factor of nucleon. The dipole-type dependence of the nucleon form factor can be reproduced for large momentum transfer. It is also shown that the theoretical form factors in the model have a simple pole near the mass of the vector mesons in the time-like region of momentum transfer. (auth)

22781 RENORMALIZATION OF THE LINEAR σ-MODEL. Mignaco, J. A. (Univ., Geneva); Remiddi, E. Nuovo Cim.; 1A: 376-94(1 Feb 1970).

The problem of the renormalization of the σ-model with nucleons is considered. Following the general lines of Lee's approach, explicit formulas are given for the relevant physical quantities as well as for the renormalization constants in the one-loop approximation. The pion decay constant and the nucleon pion vertex are evaluated. (auth)

22782 ESTIMATION OF THE PROPERTIES OF QUARKS. I. VECTOR QUARK–QUARK INTERACTION. Smith, G. B.; Tassie, L. J. (Australian National Univ., Canberra). Aust. J. Phys.; 23: 615-25(1970).

From the sum rules for hadron scattering, the nucleon form factors, and the masses of the hadrons, the properties of quarks are estimated as: $2\ \text{GeV}/c^2 \lesssim$ quark mass $\lesssim 30\ \text{GeV}/c^2$, $0.1\ \text{fm} \lesssim$ range of the quark–quark interaction $\lesssim 0.25$ fm. The hadrons are described by a relativistic independent quark model using the Dirac equation with a potential energy term for the effective interaction. This model is compared with a rigid rotor model. (auth) (Australia)

22783 ESTIMATION OF THE PROPERTIES OF QUARKS. II. SCALAR QUARK–QUARK INTERACTION. Smith, G. B. (Australian National Univ., Canberra). Aust. J. Phys.; 23: 627-32 (1970).

Describing the hadrons by a relativistic independent quark model, using the Dirac equation with a scalar potential for the effective interaction, the range of the quark–quark interaction is formed to lie between 0.3 and 0.4 fm. The hadron spectrum is shown to be independent of the quark mass and the form of the quark–quark interaction. (auth)

22784 NO-GO THEOREMS FOR DUAL MODELS. Balachandran, A. P. (Syracuse Univ., N. Y. Tata Inst. of Fundamental Research, Bombay); Chang, L. N.; Frampton, P. H. Nuovo Cim.; 1A: 545-52(1 Feb 1970).

Two no-go theorems relevant to the construction of positive-intercept dual models are stated and proved. The theorems explain why one cannot develop a physically sensible model by a simple multiplicative modification of the usual (negative-intercept) N-particle dual amplitude. (auth)

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22785 ASYMPTOTIC SINGLE-PARTICLE DISTRIBUTIONS IN THE MULTIPERIPHERAL MODEL. Bali, N. F.; Pignotti, A.; Steele, David (Univ. of Washington, Seattle). Phys. Rev., D; 3: 1167-72(1 Mar 1971).

The conjectures of Feynman and of Benecke, Chou, Yang, and Yen on the high-energy limit of single-particle distributions are studied in the framework of the multiperipheral model. It is found that classes of multiperipheral diagrams add to give limiting single-particle distributions. (auth)

22786 REMARKS ON THE POSSIBLE EXISTENCE OF STABLE OR SEMISTABLE CHARMED PARTICLES IN THE THREE-TRIPLET MODEL. Pati, J. C.; Woo, C. H. (Univ. of Maryland, College Park). Phys. Rev., D; 3: 1173-7(1 Mar 1971).

The possibility of "charm" being a reasonably good quantum number in the three-triplet model is discussed. The physical differences between the Han-Nambu model and the SUB model of Cabibbo, Maiani, and Preparata are clarified and spelled out in some detail. It is argued that under a variety of circumstances the experimental detection of integrally charged, heavy (in the 2 to 4-BeV mass region, say), long-lived charmed particles is quite feasible, provided that the SU(3) × SU(3)'' classification scheme in either model is approximately valid. The lifetimes involved are probably in the range of 10^{-12} to 10^{-8} sec. (auth)

22787 MASS RATIO OF QUARKS. Animalu, A. O. E. (Univ. of Missouri, Rolla. Drexel Univ., Philadelphia). Phys. Rev., D; 3: 1106-8(1 Mar 1971).

The concept of "convective" currents proportional to the total momentum of a spin-½ particle-antiparticle fermion system, which was recently investigated by Barut, Cordero, and Ghirardi, is applied to a quark triplet system. The "convective" currents in the triplet system are introduced as an extra SU_3 symmetry-breaking term. The field equation thus obtained involves certain constants; our particular choice of these constants leads to a relation for the quark masses that fixes the ratio m_1/m_3, where $m_1 = m_2$ is the mass of the light quarks, and M_3 is the mass of the heavy "strange" quark. The derived mass ratios provide a consistent interpretation of the mass spectra of pseudoscalar and vector mesons and the octet and decuplet baryons, if it is assumed that the mass of a composite elementary particle is directly proportional to the sum of the masses of its quark content. (auth)

22788 LEG DEPENDENCE IN THE VENEZIANO MODEL. Rabl, A. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; B27: 408-14(1971).

It is found that at large energies most of the residue functions of the factorized Veneziano amplitude (with a finite number of legs) are linearly dependent and hence cannot be counted as separate levels. Instead of an exponential degeneracy J^{21-3} is obtained as an upper bound on the number of independent states of energy J that can couple to l external legs. Infinitely many legs are required to reveal the full exponential degeneracy. The loop calculation is not affected by this leg dependence. (auth)

22789 HADRON COUPLINGS IN A QUARK REARRANGEMENT MODEL. Micu, L. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 739-47(1970).

Using a quark rearrangement model various coupling constants like $g_{N\bar{N}\pi}$, $g_{N\bar{N}\rho}$ are evaluated. Although the model is essentially a nonrelativistic one all the processes—with or without spin-flip—are treated in a consistent manner. The well-known hypothesis of meson dominance of weak and electromagnetic currents gives the Schwinger result $G_A/G_V = -5/(3\sqrt{2})$ and good values for the magnetic moments of the spin $\frac{1}{2}^+$ and $\frac{3}{2}^+$ baryons. (auth)

Strong (Baryon No. = 0)

22790 CONSTRAINTS ON THE ZEROS AND THE ASYMPTOTIC BEHAVIOR OF A VENEZIANO AMPLITUDE. Wanders, G. (Univ., Lausanne, Switzerland). Phys. Lett.; 34B: 325-7(1 Mar 1971).

Two sets of results concerning meromorphic approximations of scattering amplitudes are presented. The first one characterizes the distribution of the zeros. The second deals with the implications of the polynomial character of the residues on the asymptotic behavior. (auth)

22791 VIOLATION OF THE POMERANCHUK THEOREM AND KRONECKER-DELTA SINGULARITIES. Arai, Masahiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 44: 1654-60(Dec 1970).

Regge representations for scatterings which violate the Pomeranchuk theorem are investigated. It is shown that the partial wave amplitudes include Kronecker-delta singularities at J = 1. As a model, the case is considered in which two amplitudes are obtained from the matrix N/D method. Analytically continued partial wave amplitudes have CDD singularities when J is decreased, but the two amplitudes are the same for sufficiently large J. For this condition, the inelasticities must have a zero for real t larger than the inelastic threshold and for J between one and two. Using the Reggeized absorption model, necessary conditions are obtained. Factorizability of the terms which violate the Pomeranchuk theorem is shown, and the amplitudes of violations for $\pi\pi$, πK, and KK scatterings are estimated. (auth)

22792 PSEUDOSCALAR-VECTOR MESON SCATTERING AMPLITUDE REDUCED FROM SIX-POINT VENEZIANO MODEL. Miyata, Yasunori (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 44: 1661-72(Dec 1970).

An extension of the Veneziano model to Ps-V elastic (inelastic) scattering amplitude is presented, using the generalized Veneziano amplitude. The amplitude has the following natural properties: consistency with the original Veneziano model for $\pi\pi \to \pi\omega$ scattering amplitude and reasonable treatment for spin complications. Then one obtains relations for the coupling constants for three-vector mesons. These predicted relations are shown to be consistent with the SU(3) symmetry. (auth)

22793 TROUBLES WITH $\omega-\rho^0$ MIXING. Banyai, L. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 1: 323-6(20 Feb 1971).

In order to explain electromagnetic mass differences for $\omega-\rho^0$ mixing, the problem is approached as a second-order electromagnetic transition, taking into account only the lowest intermediary one-photon state and vector–meson dominance. The result is $m_{\rho\omega} \approx +0.6$ MeV. Looking for the contribution of the next intermediary states consisting of one photon and a pseudoscalar meson, it is found that this contribution tends to suppress the already small one-photon contribution by a factor of 0.4. It is suggested that this result either shows that there is no second-order electromagnetic-transition explanation of $\omega-\rho^0$ mixing or that such an explanation is practically impossible due to the oscillatory character of the intermediate-state expansion. (J.F.P.)

22794 GROUP-THEORETICAL CALCULATION OF THE VENEZIANO PARTIAL WIDTHS FOR $\pi-\pi$ SCATTERING. Kyriakopoulos, E. (Democritus Nuclear Research Center, Athens). Nuovo Cim.; 1A: 571-82(1 Feb 1970).

A general formula of the Veneziano partial widths for $\pi^+\pi^-$ elastic scattering is obtained within the group $SO_{3,2}$. Recursion relations for the "widths" are given. (auth)

22795 MESON TRAJECTORIES WITH INCREASING MULTIPLICITIES AND TRILOCAL FIELDS. Guersey, F.; Koca, M. (Yale Univ., New Haven). Contract AT(30-1)-2726. Nuovo Cim.; 1A: 429-44(1 Feb 1970).

A quark model with a core that was previously suggested is used to define a trilocal field to describe mesons. The field is taken to satisfy a second-order equation which is Lorentz invariant and invariant under the linear group acting on the two internal co-ordinates. The local fields occurring in the expansion of the trilocal field then describe mesons with spin J and multiplicity J on the leading $\rho-A_2$ linear trajectory. This result shows that such a scheme can accommodate the doubling of the A_2-meson and predicts tripling for the R-meson. (auth)

22796 CHIRAL LAGRANGIANS AND PION-FIELD REDEFINITION. Liu, C. J.; Chow, Y. (Univ. of Wisconsin, Milwaukee). Nuovo Cim.; 1A: 369-75(1 Feb 1970).

An explicit solution of the differential equation for Weinberg's class of chiral Lagrangians, with arbitrary $f(\pi^2)$, is given. On the contrary, for any given symmetry-breaking term the explicit solution of the corresponding $f(\pi^2)$ is not found. A chiral Lagrangian is also constructed which has the advantage of satisfying the "special" PCAC and of being independent of field redefinition and further the corresponding explicit solution of $f(\pi^2)$ is found. Two examples, corresponding to N = 1, 2 in Weinberg's class are discussed. The $\pi-\pi$ scattering lengths calculated from the proposed Lagrangian agree with Schwinger's results. (auth)

22797 POSSIBLE NEW THRESHOLD SUM RULES IMPLIED BY UNITARITY. Kwiecinski, J. (Rutherford High-Energy Lab., Chilton, Eng.). Lett. Nuovo Cim.; 1: 146-50(23 Jan 1971).

It is pointed out that unitarity may be explored further, and leads to new sum rules for the crossed-channel absorptive parts for fixed t at the elastic threshold. The partial-wave amplitude for $\pi\pi$ scattering is considered. (J.F.P.)

22798 BRANCH CUTS IN THE BALAZS METHOD. II. APPLICATION TO PION–PION SCATTERING. Gibbons, Thomas;

Dilley, James (Ohio Univ., Athens). Phys. Rev., D; 3: 1196-1205(1 Mar 1971).

The modified Balázs method, which retains the near part of the left-hand cut, is studied with regard to its ability to reproduce known, resonant functions and is applied to the pion–pion scattering problem. The known functions are reproduced reliably, with little dependence on the matching points and the number of poles, provided that sufficiently good estimates of the gap and the cut are used, and that the pole positions are chosen to optimize the agreement in the gap. The pion–pion results show a systematic improvement as crossed-channel partial waves are added to the input, and four partial waves are sufficient to produce the ρ and f^0 in rough agreement with experiment. These calculations do not use cutoffs, other arbitrary adjustable parameters, Castillejo–Dalitz–Dyson poles, coupling to other channels, or inelasticity. (auth)

22799 ANOMALOUS WARD IDENTITIES AND ω-MESON DECAYS. Ali, Ahmed; Hussain, Faheem (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., D; 3: 1206-13(1 Mar 1971).

The strong decay $\omega \to \pi^+\pi^-\pi^0$ and the photopion reaction $\gamma + \pi \to \pi + \pi$ are discussed using the hard-pion current-algebra technique. The anomalous Ward identities for three- and four-point functions are used to determine the structure of the contact term, which could not be determined completely. Both the $\omega \to 3\pi$ and the $\gamma - 3\pi$ amplitude are then expressed in terms of three parameters $g_{\omega\rho\pi}$, ξ (which characterizes the contact term), and δ (the parameter which appears in the $A_1\rho\pi$ system). $g_{\omega\rho\pi}$ is determined from a fit to the experimental $\omega \to \pi^0\gamma$ decay width and this value of $g_{\omega\rho\pi}$ is used to determine the $\omega \to 3\pi$ width and the ratio $\Gamma(\omega \to \pi^0\gamma)/\Gamma(\omega \to 3\pi)$ for the various values of δ, ignoring the contact term. Next ξ is estimated by using the experimental decay width for $\omega \to 3\pi$ and the resulting $\omega \to 3\pi$ amplitude is used to estimate $f_{\gamma-3\pi}$. The effect of anomalous Ward identities on the $\pi^0 \to \gamma\gamma$ form factor is also estimated and the value of F(0,0,0) for $b_1 = 0$ and $2b_1 = 3\gamma$ is obtained. (auth)

22800 OFF-MASS-SHELL EFFECTS IN $\omega \to 3\pi$ DECAY. Ali, Ahmed; Hussain, Faheem (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., D; 3: 1214-17(1 Mar 1971).

Off-mass-shell effects in $\omega \to 3\pi$ decay are discussed in the context of hard-pion current-algebra technique. Anomalous Ward identities are used instead of the naive ones. The decay amplitude depends upon ξ, which characterizes the contact term, and δ, the parameter appearing in the $A_1\rho\pi$ system. Results for $\Gamma(\omega \to 3\pi)$ for $\delta = 0$ to $\delta = -1$ are presented. (auth)

22801 MODEL FOR $\pi-\pi$ SCATTERING SATISFYING ANALYTICITY AND CROSSING SYMMETRY. Moffat, J. W. (Univ. of Toronto). Phys. Rev., D; 3: 1222-33(1 Mar 1971).

A crossing-symmetric model for $\pi-\pi$ scattering is presented which satisfies the Mandelstam representation, has a finite number of resonances associated with an exchange-degenerate trajectory that turns over at high energies, and which has Regge asymptotic behavior in all channels. The Pomeranchukon amplitude is nonresonating and has background cuts. The total amplitude satisfies the Adler condition. Satellites are included that eliminate all the odd-daughter (ghost) resonances. The double-spectral functions are calculated and shown to have, except for the lack of curvature, the correct boundaries determined by elastic unitarity. The structure of the second-sheet singularities is briefly discussed. The $\pi-\pi$ scattering lengths are calculated and found to be consistent with those obtained from current algebra, when terms of order m_π^2 and unitarity corrections are neglected. (auth)

22802 APPLICATION OF A CROSSING-SYMMETRIC MODEL SATISFYING THE MANDELSTAM REPRESENTATION TO $\pi-\pi$ AND K$-\pi$ SCATTERING. Curry, P.; Moen, I. O.; Moffat, J. W.; Snell, V. (Univ. of Toronto). Phys. Rev., D; 3: 1233-52(1 Mar 1971).

A model for meson-meson scattering satisfying the Mandelstam representation, crossing symmetry, and Regge behavior and including a Pomeranchukon amplitude is applied to $\pi-\pi$ and K$-\pi$ scattering. Solutions are found for the K$-\pi$ partial waves that satisfy unitarity approximately at low energies, give a satisfactory fit to the on-mass-shell data, and predict scattering lengths consistent with current algebra. Apart from a change in the coupling constant, effectively the same parameters are then used to predict the low-energy $\pi-\pi$ scattering, and the solutions are found to satisfy unitarity approximately up to 900 MeV. The predicted on-mass-shell results agree well with the available data. The general conditions below threshold for $\pi-\pi$ scattering that follow from crossing symmetry and positivity are well satisfied. The extrapolated $\pi-\pi$ and K$-\pi$ amplitudes off the mass shell are found to agree satisfactorily with the data for $\pi N \to \pi\pi N$ and $KN \to K\pi N$ when a phenomenological form factor is used in the extrapolation. The total and differential cross sections at high energy are found to have characteristic Regge behavior. The Pomeranchukon amplitude produces total $\pi-\pi$ and K$-\pi$ cross sections consistent with factorization in the asymptotic region. (auth)

22803 VENEZIANO-TYPE AMPLITUDE FOR $\pi\pi \to \pi\gamma$ TESTED IN $\pi N \to \pi N\gamma$. Schiller, D. H. (Univ. of Timisoara, Romania); Raszillier, I. Rev. Roum. Phys.; 15: 799-804(1970).

The possibility to extract the radiative decay width of the ρ-meson from πN-bremsstrahlung experiments, using a Veneziano-type amplitude for $\pi\pi \to \pi\gamma$ is investigated. No compatibility with experiment is obtained unless off-shell effects are unexpectedly large. (auth)

22804 SUM RULE FROM A PION LIFETIME CALCULATION INCLUDING $\bar{N}N$, $\rho\pi$ AND $\sigma\pi$ INTERMEDIATE STATES. Coleman, Robert Alan. Toronto; Univ. of Toronto (1969). Available from National Library of Canada at Ottawa.

Thesis.

The main theme is the pion lifetime calculation and its relation to the Goldberger-Treiman relation. The original calculation of Goldberger and Treiman is followed in assuming that the form factor $F_\pi(\xi)$, defined by the single pion matrix element of the divergence of the axial vector current, satisfies an unsubtracted dispersion relation. However, in addition to the $\bar{N}N$ intermediate state contribution to IM $F_\pi(\xi)$ considered in their calculation, $\rho\pi$ and $\sigma\pi$ intermediate state contributions to IM $F_\pi(\xi)$ are included. The original calculation as well as some modifications and corrections that were proposed are reviewed. The general formalism used in the calculation is developed. Necessary form factors are defined and expressions are obtained for them. Then two calculations are presented. In the first it is assumed that the form factors $\gamma_{\rho\pi\pi}(\xi)$, $G_{NN\pi}(\xi)$ and $\gamma_{\sigma\pi\pi}(\xi)$ satisfy once-subtracted dispersion relations, and in the second it is assumed they satisfy unsubtracted dispersion relations which are dominated by a resonance with $I = 1$ and $J^P = 0^-$. In both cases a generalized Kawarabayashi-Suzuki-Riazuddin-Fayyazuddin relation results from the imposition of a convergence condition. In the first case a modified Goldberger-Treiman relation is obtained by imposing another convergence condition. However, the corrections are in the wrong direction even though they are probably very small. In the second case, it is found possible to make the modified Goldberger–Treiman relation agree with experiment if the resonance mass is approximately 2 GeV. A reprint of a published paper on a two-dimensional relativistic quark model with exact solutions is also given. This work is based on the extension of the Thirring model to N fermion fields interacting by a current current coupling. Equal time commutation relations are discussed in terms of the exact solution and are found to be canonical in form. (Diss. Abstr. Int., B)

22805 GREEN'S FUNCTION FOR THE BETHE–SALPETER EQUATION. Hormozdiari, Iraj. Columbia, Mo.; Univ. of Missouri (1970). 152p. University Microfilms Order No. 71-3338.

Thesis.

Four possible Green's functions of the Bethe–Salpeter equation for equal mass scalar bosons were studied by considering contours in an off the mass shell complex energy (Ω) plane and an on the mass shell magnitude of 3-momenta (k) or energy (ω_k) complex plane. It is found that three of the Green's functions—causal, retarded, and advanced Green's function cannot lead to scattering solutions. Only a new Green's function which is called the scattering Green's function, with appropriate restrictions on the interaction V(x) can lead to scattering states. It is also shown that the scattering Green's function is the correct Green's function for bound states. (Diss. Abstr. Int., B)

22806 $\pi\pi$ SCATTERING LENGTHS IN THE $m_\sigma = \infty$ LIMIT. Alles, W.; Mazzanti, P.; Salvini, M. (Univ., Bologna. Instituti Nazionale di Fisica Nucleare, Bologna). Lett. Nuovo Cim.; 1: 277-80(13 Feb 1971).

The consequences in the tree approximation of the most general SU(2) × SU(2)-invariant Lagrangian broken by a σ term leading to PCAC, when the renormalizability condition is dropped from the beginning, are studied. The $\pi\pi$ scattering lengths are calculated. (J.F.P.)

22807 CALCULATION OF EFFECTS OF BOX DIAGRAMS WITH TWO RESONANCES IN INTERMEDIATE STATE. Anisovich, V. V.; Kobrinskii, M. N. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 13: 168-80(Jan 1971). (In Russian).

Box diagrams with resonances in the intermediate state have singularities that may be close to the physical region. The singular parts of such graphs are calculated in an explicit form in case of the scalar and vector resonances. Conditions for the singularities

to be close to the physical region are investigated in detail. Effects are calculated that arise in certain processes. (auth)

22808 PADE APPROXIMANTS FOR THE PARTIAL AMPLITUDES OF THE $\pi\pi$ INTERACTION. Idiatulin, V. S.; Fil'kov, L. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: 181-6(Jan 1971). (In Russian).

The interaction of the dispersion relations with one subtraction is used to construct [12] and [21] Pade approximants for s, p, d and f waves of $\pi\pi$ scattering. The analysis of these waves at small energies and below the threshold is performed which indicates the existence of "antibound" states in d wave with I = 0 and I = 2 with the effective masses ~3 and ~1 MeV respectively. (auth)

22809 CURRENT CONSERVATION, VDM, AND DECAY PROCESSES. Mannheim, P. D.; Nussinov, S. (Tel Aviv Univ., Israel). Nuovo Cim.; 1A: 619-24(21 Feb 1971).

It is shown that current conservation, VDM, and an assumption as to the suitable form factors for VDM, enable one to make predictions on decay processes involving vector mesons. (auth)

22810 QUARK GRAPHS AND ANGULAR DISTRIBUTIONS IN POSITIVE-PARITY MESON DECAYS. Colglazier, E. W. (California Inst. of Tech., Pasadena); Rosner, J. L. Contracts AT(11-1)-68; AT(11-1)-1764. Nucl. Phys.; B27: 349-71(1971).

Using a model of mesons decaying via production of a quark-antiquark pair with the quantum numbers of the vacuum, the angular distributions in the decays $A_1 \to \rho\pi$ and $B \to \omega\pi$ are related, predicting $2(g_1/g_0)_{A_1} = (g_0/g_1)_B + 1$. This relation is consistent with the present, somewhat ambiguous experimental data. Also a satisfactory description is given, in terms of two parameters, of the partial widths of the 0^+, 1^+ and 2^+ mesons decaying into 1^-0^- and 0^-0^- pairs. The prediction of the model is that $SU(6)_W \times O(2)_{L_Z}$ relations hold among all the D-waves and among all the S-waves, but not between the two groups. In fact, our two-parameter fit to the data entails a ratio of S-wave to D-wave amplitudes of approximately the same magnitude but opposite sign to that implied by $SU(6)_W \times O(2)_{L_Z}$. Unlike the widths, the angular distributions are sensitive to the relative sign and are thus crucial in determining that the fit of our model differs considerably from the $SU(6)_W$ solution. Parameters of the fit are applied to the 1^+ kaons, which may mix with one another. The results are sensitive to the mixing angle ϕ, and merely assuming lower bounds on widths of both physical states establishes the limits $10^0 \le \phi \le 35°$. As a result of this mixing, the following is predicted: (i) the suppression of the $K^*\pi$ mode of the lower peak, (ii) the suppression of the ρK mode of the upper peak, and (iii) decay distributions in the $K^*\pi$ mode similar to that of the A_1 for the lower state and to that of the B for the higher. (auth)

22811 $\bar{p}p$ ANNIHILATIONS AT REST. THE $K\bar{K}\omega$ CHANNEL. MASS, WIDTH, AND BRANCHING RATIO OF THE ω-MESON. Bizzari, R. (CERN, Geneva); Montanet, L.; Nilsson, S.; d'Andlau, Ch.; Cohen-Ganouna, J. Nucl. Phys.; B27: 140-8(1971).

Data on $\bar{p}p$ annihilations at rest into $K_1^0K_1^0\omega^0$ and $K^+K^-\omega^0$ are discussed. New measurements for the mass, the width and the branching ratio of the ω^0 are presented. Evidence for quasi two-body annihilations $\bar{p}p \to \varphi\pi$, $\bar{p}p \to S^*\pi$ is discussed. (auth)

22812 OFF SHELL πK AMPLITUDES CONSISTENT WITH CHIRAL SYMMETRY BREAKING AND THE BJORKEN LIMIT. Horwitz, Paul (Univ. of Oregon, Eugene). Contract AT(45-1)-2041. Nucl. Phys.; B27: 193-204(1971).

A two-parameter family of $\pi K \to \pi K$ amplitudes with two π or a π and a K off the mass shell. They describe scattering with arbitrary daughter states and reduce to a finite series of Veneziano-like terms (satisfying the Adler-zero condition) when at least one momentum is on a particle or daughter pole. They possess Bjorken limit behavior in a finite region of the stu plane. With one π or one K soft, they are consistent with $u_0 + cu_8$ symmetry breaking. The exact Bjorken limit behavior determines one of the parameters. A modified KSFR relation, and calculations of c and $f_w/f_+(0)f\pi$ make possible a comparison with experiment. (auth)

22813 CROSSING-SYMMETRIC MODEL FOR $\pi\pi$ SCATTERING WITH SOME UNITARY ASPECTS. Milgram, Michael S. (Univ. of Toronto). Nucl. Phys.; B27: 205-20(1971).

A class of functions are devised which incorporate some of the properties thought to be appropriate to the S-matrix for $\pi\pi$ scattering from considerations of unitarity, crossing symmetry, Lorentz invariance and analyticity. The imposition of Regge asymptotics limits the acceptability of some of these functions. Further elimination is obtained by demanding unitary threshold behavior in all partial waves. Examples of some simple functions containing most of the desired properties save exact elastic unitarity are presented. (auth)

22814 RELATIONS AMONG REGGE TRAJECTORIES AND DUAL RESONANCE MODEL. Hara, Yasuo (Tokyo Univ. of Education). Nucl. Phys.; B27: 314-26(1971).

The dual resonance model of the strong interaction of the P_8 mesons and that of the semi-leptonic weak interaction of the P_8 mesons are studied. Relations among Regge trajectories are derived. The poles of the P_8 mesons are found not to be able to appear in the dual resonance amplitudes. It is suggested that the P_8 mesons, π, K and η, are not Regge poles but elementary particles. (auth)

22815 $\epsilon\mathcal{N}\mathcal{N}$ AND $\epsilon\pi\pi$ COUPLINGS. Genz, H.; Steiner, F. (Univ., Karlsruhe, Ger.). Lett. Nuovo Cim.; 1: 355-7(27 Feb 1971).

The coupling $g_\epsilon T_\mu^\mu \epsilon$ (with $T_{\mu\nu}$ the usual energy-momentum tensor) is investigated in the tree approximation. The ratio of the coupling constants $R = G_{\epsilon NN}/G_{\epsilon\pi\pi}$ is found to be 1.24. Evidence is found that ϵ couples to the trace of the usual symmetric energy-momentum tensor. (J.F.P.)

Strong (Baryon No. = 1)

22816 (UCRL-72943(Rev.1)) ON THE NATURE OF HADRON ROTATIONAL LEVELS. Mac Gregor, Malcolm H. (California Univ., Livermore. Lawrence Radiation Lab.). 2 Feb 1971. 18p. (CONF-710106-4). Dep. NTIS.

From Conference on Fundamental Interactions at High Energy, Coral Gables, Fla.

It is demonstrated that it appears possible to use a nuclear physics approach in the classification of nucleon and hyperon resonances if account is taken of rotational systematics. The S state nucleon excitation levels, and rotational bands for the nucleon and hyperon resonances are shown. (J.F.P.)

22817 NON-DUAL PROPERTY OF A PION AND ITS PRODUCTION PROCESS. Kagiyama, Shigenori; Uehara, Masayuki (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 44: 1713-15(Dec 1970).

It is assumed that pion exchange is nondual to the resonances irrespective as to whether it is elementary or not. Single pion production processes are discussed to give a unified model in which the diffraction dissociation mechanism and the peripheral resonance production are treated in a unified description. The process $\pi + N \to \pi + \pi' + N'$ is discussed. (J.F.P.)

22818 AN UPPER BOUND ON POMERANCHUK THEOREM VIOLATION IN KN SCATTERING. Finkelstein, J.; Roy, S. M. (CERN, Geneva). Phys. Lett.; 34B: 322-4(1 Mar 1971).

An upper bound on the asymptotic total cross section difference $[\sigma_{tot}^{K^-n} - \sigma_{tot}^{K^+n}]$ in terms of the integrated cross section for $K_L^0p \to K_S^0p$ scattering is derived and shown to be almost saturated by presently available data. (auth)

22819 TOTAL PHOTOABSORPTION IN NUCLEI AND THE VALUE OF THE RHO-NUCLEON CROSS-SECTION. Mennessier, G.; Nachtmann, O. (Faculte des Sciences, Orsay, France). Phys. Lett.; 34B: 309-11(1 Mar 1971).

Using experimental information from ρ-photoproduction on hydrogen instead of strict vector meson dominance, it is shown that the total photoabsorption in nuclei is insensitive to the ρ-nucleon cross section $\sigma_{\rho N}$. Therefore, a recent SLAC experiment is compatible with a much higher value for $\sigma_{\rho N}$ than quoted previously. (auth)

22820 OPTICAL MODEL AND ρ-MESON MATTER DENSITY. Egusa, Toshimasa; Morii, Toshiyuki (Osaka Univ., Toyonaka, Japan). Progr. Theor. Phys. (Kyoto); 44: 1706-7(Dec 1970).

The ρ-meson matter density, which is related to the optical potential in view of the droplet model and is important to high-energy reactions, is investigated for two reactions $\gamma + p \to \rho + p$ and $\pi + p \to \rho + p$. (J.F.P.)

22821 N_α AND N_γ TRAJECTORIES IN THE BACKWARD $K^-n \to \Lambda\pi^-$ REACTION. Iwao, Syurei; Tashiro, Tsutomu (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 44: 1703-5(Dec 1970).

The data for the backward $K^- + n \to \Lambda + \pi^-$ reaction are analyzed by taking two poles N_α and N_γ into account. Restriction on the Regge parameters is sought neglecting the effect of their parity partners. It is concluded that if a parameter flexibility is not admitted, then N_α and N_γ should be nondegenerate trajectories. (J.F.P.)

22822 CALCULATION OF THE FIRST DIAGONAL PADE APPROXIMANT TO π-N ELASTIC SCATTERING WITH THE σ-

MODEL. Mignaco, J. A. (Univ., Geneva); Remiddi, E. Nuovo Cim.; 1A: 395-428(1 Feb 1970).

The first diagonal (unitary) Padé approximant for elastic pion–nucleon scattering is evaluated within the renormalized σ-model of Gell-Mann and Lévy by computing the perturbative S-matrix up to 4th order (one-loop approximation). The resulting phase shifts are studied as a function of the σ-meson mass and the meson–nucleon coupling appearing in the renormalized Lagrangian, which are the only two parameters left free in the theory. Solutions remarkably good for the P_{33} and S_{31} waves having also a resonating P_{11} are obtained for low σ masses. For big enough values of that parameter other solutions agreeing with the experimental S-wave phase shifts up to 1400 MeV of c.m.s. energy are obtained, as is desirable, from the relation between "tree" graph calculations of the model and current algebra. For all interesting solutions the effective pion–nucleon coupling constant lies within 40% of its experimental value, and the pion decay constant obtains somewhat better. However, agreement for all partial waves simultaneously is never achieved and some of the physically small phase shifts show ghosts when the σ mass is pushed to high values. (auth)

22823 K^+p PARTIAL-WAVE AMPLITUDES BELOW 2 GeV/c. Lea, A. T. (Rutherford High Energy Lab., Chilton, Eng.); Martin, B. R.; Thompson, G. D. Nucl. Phys., B26: 413-32(1971).

A critical survey of K^+p phase-shift analyses is presented, and the use of forward dispersion relations to compare solutions is discussed. A quantitative analysis of the remaining solutions is made, and experiments suggested to decide between them. (auth)

22824 REGGE CUTS AND FORWARD PION–NUCLEON SCATTERING. Schiff, D. (Univ. of Maryland, College Park. Laboratoire de Physique de Hautes Energies, Orsay, France); Violini, G. Lett. Nuovo Cim.; 1: 309-13(20 Feb 1971).

The information obtained from simultaneous fits to the finite-energy sum rules and total cross sections for π + N scattering is discussed. It is found that the inclusion of Regge cuts certainly improves the description of the high-energy scattering amplitude. (J.F.P.)

22825 ONE-PHOTON-EXCHANGE CONTRIBUTION TO INELASTIC HADRONIC COLLISIONS. Patil, S. H. (Indian Inst. of Tech., Bombay); Rajaraman, R. Nucl. Phys., B26: 258-62 (1971).

The contribution of one-photon exchange to pp and πp inelastic cross sections at high energies is calculated. It is shown that these are of increasing importance at higher energies. In particular, the interference of this amplitude with the purely strong amplitude can contribute about a millibarn to $\sigma(ab) - \sigma(\bar{a}b)$ at Serpukhov energies. This may well explain the observed difference between $\sigma(\pi^-p)$ and $\sigma(\pi^+p)$. (auth)

22826 PHASE OF SURFACE REACTIONS AND POLARIZATION IN ELASTIC $\pi^\pm p$ SCATTERING. Berlad, G.; Dar, A.; Eilam, G. (Technion-Israel Inst. of Tech., Haifa). Lett. Nuovo Cim.; 1: 339-45(20 Feb 1971).

An explanation of the polarization in elastic $\pi^+ + p$ and $\pi^- + p$ interactions is given, which results from the analyticity and crossing properties of surface reactions and is consistent with the explanation of the dips and spikes observed in the t-dependence of exchange reactions. (J.F.P.)

22827 NATURAL- AND UNNATURAL-PARITY COMPONENTS IN DIFFRACTIVE MULTI MESON PRODUCTION AMPLITUDES. Meggs, W. J.; Van Hove, L. (CERN, Geneva). Nucl. Phys., B26: 245-57(1971).

The amplitude for the diffractive dissociation of a pseudoscalar meson into pseudoscalar mesons on a proton is decomposed into natural- and unnatural-parity components of the dissociated system. Unnatural parity is expected to dominate. Methods are discussed to detect a natural-parity component without making assumptions on the spin of the dissociated system. This can be done for forward dissociation and, in case of axial symmetry for the dissociated system, for nonforward dissociation. The method consists in performing the dissociation on a longitudinally-polarized proton target. The interference between natural- and unnatural parity components is then directly measurable. (auth)

22828 QUARK MODEL FOR DOUBLE-CHARGE-EXCHANGE MESON–BARYON SCATTERING. Chand, Ramesh (MATSCIENCE, Madras). Phys. Rev., D; 3: 1165-7(1 Mar 1971).

In an SU_3-symmetric quark model, double-charge-exchange scattering processes of the type $PN \to P'B$, $\Delta Q(P,P') = \pm 2$, are investigated. The physical baryon octet is taken as 8(physical) = $8'\cos\theta + 8\sin\theta$, where 8 and $8'$ arise, respectively, from $3 \otimes \bar{3}$ and $3 \otimes 6$ contained in $3 \otimes 3 \otimes 3$. In terms of the mixing angle θ, a number of predictions are made. (auth)

22829 REMARK ON THE KINEMATICAL STRUCTURE OF HELICITY AMPLITUDES FOR BOSON–FERMION SCATTERING. Vervoort, P. M. (Univ. of Nijmegen, Netherlands). Lett. Nuovo Cim.; 1: 281-4(13 Feb 1971).

The problem of removing kinematical singularities from helicity amplitudes for two-body scattering processes was previously solved. The necessary modifications of a previous method are given, and a set of amplitudes are constructed which are kinematically regular in the W(cm energy)-plane. The parity-conserving amplitudes, free of kinematical singularities in the W plane are given for the general case of boson-fermion scattering. Also the process $\pi + N \to K + \Sigma$ is discussed. (J.F.P.)

22830 EXPERIMENTAL INVESTIGATION OF THE MANDELSTAM BRANCH POINTS. Dubovikov, M. S. (Moscow Physical-Technical Inst.). Yadern. Fiz.; 13: 164-7(Jan 1971). (In Russian).

Formulas are obtained that enable one to extract the contribution from the Mandelstam branch points, with parity opposite to that of the pole, from the experimental data, assuming that the asymptotics of the reaction $\Pi + p \to R + p$ (Π is a pseudoscalar meson and R is a boson resonance) is dominated by the pole and the branch generated by the pole. (auth)

22831 PARTIAL WAVE AMPLITUDES FOR $\pi^\pm p$ ELASTIC SCATTERING AND CHARGE EXCHANGE IN THE 1.5 TO 2.5 GeV/c REGION. Roychoudhury, R. K.; Bransden, B. H. (Univ. of Durham, Eng.). Nucl. Phys.; B27: 125-39(1971).

The experimental $\pi^\pm p$ elastic-scattering and charge-exchange data in the momentum region 1.5 to 2.5 GeV/c was fitted by a model proposed by Roychoudhury, Perrin and Bransden, and from parametrised amplitudes, phase-shift parameters are subsequently obtained by partial-wave projection. (auth)

22832 APPLICATION OF THE GENERALIZED VENEZIANO MODEL TO $K^-p \to K^{*-}\pi^-\Delta^{++}$ AND $\pi^+p \to K^+K^{*-}\Delta^{++}$. Baier, R. (Univ., Graz); Kuehnelt, H.; Widder, F. Nucl. Phys.; B27: 372-80(1971).

The reaction $K^-p \to K^{*-}\pi^-\Delta^{++}$ is studied at 4.25 GeV/c and 10 GeV/c in the framework of the generalized Veneziano model and compared with experimental data at the lower energy. Also the reaction $\pi^+p \to K^+K^{*-}\Delta^{++}$ is briefly considered. (auth)

22833 HELICITY CONSERVATION AND THE GRIBOV–MORRISON PARITY RULE IN DIFFRACTIVE PION PRODUCTION. Bialas, A. (Jagellonian Univ. Inst. of Nuclear Physics, Krakow); Dabkowski, J.; Van Hove, L. Nucl. Phys.; B27: 338-48 (1971).

The behavior of the π-nucleon and πΔ (1238) systems produced diffractively in high energy πp and Kp collisions is analyzed under the assumption of helicity conservation and parity rule $\Delta p = (-1)^{\Delta J}$. The two possibilities of s-channel and t-channel helicity conservation are considered. The well-known Treiman-Yang test is generalized for the case of s-channel helicity conservation. The πN and πΔ systems are analyzed in partial waves in their rest frame, and the number of individual partial waves is found to be strongly reduced by the combined assumption of parity rule and helicity conservation. Tests for the combined assumption are discussed. They require polarization experiments for π nucleon but some deal with angular and decay distributions in the πΔ case. (auth)

22834 POMERON STRUCTURE FROM LOW-ENERGY K^+p SCATTERING. Myers, C.; Salin, Ph. (Faculte des Sciences, Bordeaux). Nucl. Phys.; B27: 33-44(1971).

Using phase-shift analysis and high-energy Regge terms as input, the pomeron amplitude in K^+p elastic scattering below 2.5 GeV/c is evaluated taking into account pomeron-Regge cut contributions. The results show linear s-dependence for this amplitude and exponential t-dependence with step-wise increasing slope at each strongly coupled inelastic threshold. Spin conservation is favored though s-channel helicity conservation cannot be excluded for some phase-shift solutions. (auth)

22835 FINITE-ENERGY SUM RULES WITH COMPLEX CONJUGATE REGGE POLES IN πN CHARGE EXCHANGE. Nagylaki, Thomas (Univ. of Colorado, Boulder). Phys. Rev., D; 3: 1263-4(1 Mar 1971).

A pair of complex conjugate Regge poles is used to parametrize the contribution of the ρ trajectory and of the cut arising from its coupling with the Pomeranchuk trajectory to the $B^{(-)}$ amplitude in πN charge exchange. It is argued that the previous result of Aviv and Horn, that finite-energy sum rules require additional Regge structure in this amplitude, still holds. (auth)

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22836 DUALITY IN BACKWARD π^+p ELASTIC SCATTERING. Ma, Ernest S.; Shaw, Gordon L. (Univ. of California, Irvine). Phys. Rev., D; 3: 1264-6(1 Mar 1971).

A duality-inspired model for the scattering amplitude is used to explain backward π^+p elastic-scattering data from 2.18 GeV/c (incident pion laboratory momentum) on up. The quantitative success of this model gives support to the assumption that the dip at $u \sim -0.15$ GeV^2 is due to a wrong-signature nonsense zero in the N_α Regge-pole exchange amplitude. A particularly interesting polarization prediction (which can soon be compared with experimental data) is also presented. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 23102.

22837 (INP-712(Vol.1), pp 107-43) COHERENT AND INCOHERENT REACTIONS AND DIFFRACTION. Margolis, B. (McGill Univ., Montreal (Quebec)).

In Proceedings of the X Cracow School of Theoretical Physics. Volume I.

Some of the uses of heavy nuclei in high-energy physics are considered. The physics of production and scattering of high-energy particles on nuclei and on nucleons is investigated together. A physical approach is used with minimal emphasis on derivations. Coherent and incoherent reactions, classical treatment, eikonal methods in Glauber theory, the effect of nuclear correlations are considered. Production in the infinite-energy limit, coherent and incoherent production at finite energy, coherent protoproduction of ρ^0, diffractive processes on protons, diffractive production, and K regeneration and elastic K scattering are also discussed. (J.F.P.)

22838 (ITF-70-71) ON THE FAST π-MESON SCATTERING BY NUCLEI. Sitenko, A. G.; Dotsenko, I. S.; Fursa, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 15p. (In Russian). Dept. NTIS (U.S. Sales Only).

The fast π-meson scattering by nuclei is considered on the basis of a multipole formalism. The impulse approximation is used. The amplitude of the pion-nucleon interaction is chosen according to the experimental data on the π-meson scattering on free nucleons. The numerical calculations of angular distributions of the elastic scattering of negative π-mesons on nuclei ^{12}C are carried out as well as the inelastic scattering of negative π-mesons with the excitation level $2^+T = D/\gamma, \gamma\gamma$ MeV of nucleus ^{12}C. A good agreement with experimental data in a wide interval of energies is obtained. (auth)

22839 (JINR-P4-5510) ON SOME POSSIBILITIES OF SOLVING THE FADDEEV EQUATIONS WITH THE POTENTIALS OF ARBITRARY FORMS. Belyaev, V. B.; Zubarev, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

Some practical potentialities of the separable expansion of partial harmonics of the nucleon-nucleon potential $V_l(K,K')$ of an arbitrary form are considered here. It turned out that the most universal expansion has the following form $V_l(K,K') = \Sigma_{ij=1}^{N}(d^{-1})_{ij}\, P(K_i S_i)\, P(K'_j S_j)$, where $d_{ij} = V_l(S_i,S_j)$ and P is the interpolation function, $P(S_\mu,S_i) = V_l(S_\mu,S_i)$, $\mu = 1, \ldots N+M$, $i = 1, \ldots N$. The possibility of the direct application of the formula of the mechanical quadrature to expression $V_l(K,K') = (1/2\pi^2)\int_0^\infty V(r)r^2 j_l(Kr)\, j_l(K'r)dr$ is also discussed. Such factorization appears to be the most effective for the square well potential and for potential with the infinite repulsion at the small distances. The separable representations of potential $V_l(K,K')$ based on the expansions of the form $j_l(Kr) = \Sigma_m C_{lm}(K)\, H_m(r)$ are discussed as well. The proof of the uniform convergence of Beitmans' expansion $V(K,K') = \Sigma(d^{-1})_{ij}\, V(K,S_i)\, V(S_j K')$ is given. (auth)

22840 (NP-18585) SHELL-MODEL ANALYSIS OF Λ-BINDING ENERGIES FOR THE p-SHELL HYPERNUCLEI. I. BASIC FORMULAE AND MATRIX ELEMENTS FOR ΛN AND ΛNN FORCES. Gal, A. (Hebrew Univ., Jerusalem (Israel). Dept. of Theoretical Physics); Soper, J. M. (Atomic Energy Research Establishment, Harwell (England)); Dalitz, R. H. (Oxford Univ. (England). Dept. of Theoretical Physics). [1970]. 121p. Dep. NTIS (U. S. Sales Only).

A uniform intermediate-coupling shell model is formulated for the p-shell Λ hypernuclei, those belonging to the configuration $\{(1s)_N^4(1p)_N^{A-5}(1s)_\Lambda\}$, by using NN parameters obtained from previous fits to the corresponding core nuclei. The physical origins of the ΛN forces are discussed, with special attention to the non-central components, and the characteristics of the three-body double-OPE ΛNN interaction are reviewed briefly. Expressions are derived for all the ΛN and ΛNN matrix elements needed for the discussion of these configurations. Attention is particularly drawn to their qualitative characteristics. For the purpose of orientation, numerical estimates of them are given for all the possible types of ΛN force and for all the constituents of the double-OPE ΛNN interaction, with explicit forms used for the radial wave functions. (68 references) (auth)

22841 (TID-25665) DECAY RATE AND BRANCHING RATIO $(\pi^- {}^3He)/(ALL\ \pi^-$ MODES) OF $^3_\Lambda H$. Ram, B.; Williams, W. (New Mexico State Univ., Las Cruces. Dept. of Physics). [1970] 12p. Dep. NTIS.

The total decay rate and branching ratio $R_3 = (\pi^- {}^3He)/(all\ \pi^-$ modes) of $^3_\Lambda H$ were calculated, using spatial wave functions for ^3He and $^3_\Lambda H$ obtained in recent years by Herndon and Tang on the basis of their variational calculations of these systems in terms of NN and ΛN potentials with hard cores. The results are about the same as those previously obtained using wave functions without hard-core distortions. (auth)

22842 PARTICLE-PARTICLE ELASTIC SCATTERING AT 90^0. Muraki, Yasushi (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 44: 1711-13(Dec 1970).

A model is presented for the flat distribution near 90° in the differential cross section in p + p elastic scattering. Also, it is predicted that the isotropic angular distribution near 90° appears in neutrino-hadron elastic scattering. (J.F.P.)

22843 $\pi\pi$ SCATTERING AND THE π-DEUTERON SCATTERING LENGTH. Vickson, R. G. (Univ. of British Columbia, Vancouver). Nucl. Phys., B26: 349-64(1971).

The effects of $\pi\pi$ scattering (excluded from the usual multiple-scattering approach) are studied for very low-energy πd elastic scattering. These are found to be possibly as large as 25% of the multiple-scattering contribution. Difficulties with the interpretation of the results are also discussed. (auth)

22844 COMMENT ON THE FORWARD pp DISPERSION RELATION. Liu, Yu-chien; McGee, Ian J. (Univ. of Waterloo, Ont.). Phys. Rev., D; 3: 1261-2(1 Mar 1971).

It is argued that the unphysical region and the spin-dependence problem in forward pp scattering can be done away with at high energy, maintaining the phenomenological usefulness of the forward pp dispersion relation. (auth)

22845 TWO-PION-EXCHANGE CONTRIBUTION TO NUCLEON-NUCLEON SCATTERING. Binstock, Judith (Texas A and M Univ., College Station). Phys. Rev., D; 3: 1139-51 (1 Mar 1971).

The two-pion-exchange contribution to nucleon-nucleon scattering is calculated, following the method of Goldberger, Grisaru, MacDowell, and Wong. The results are shown for two cases. In the first case, the input $\pi\pi \to \bar{N}N$ amplitude is approximated by a nucleon pole term only; in the second case it is approximated by a nucleon pole term plus a $\Delta(1236)$ pole term. It is found that for the physical value of the $\Delta(1236)$ width, $\Gamma_\Delta = 120$ MeV, there is very little difference for the two cases in the resulting effect on nucleon-nucleon scattering below 400 MeV. The model is mathematically equivalent to the Amati-Leader-Vitale approach for all but $^1S_0$, $^3P_0$, and $^3P_1 NN$ partial waves. The results are found to be sensitive to the value of Γ_Δ. (auth)

22846 STATISTICAL THERMODYNAMICS OF HADRON GAS AND LIQUID DROPS. Imaeda, K. (Dublin Inst. for Advanced Studies). Lett. Nuovo Cim.; 1: 290-4(13 Feb 1971).

The existence is deduced and the consequences are discussed of the liquid state of hadrons on the multiple meson production. The example of a head-on nucleon-nucleon collision is considered. (J.F.P.)

22847 HIGH-ENERGY DEUTERON-DEUTERON INTERACTION AND INELASTIC PROCESSES. Kancheli, O. V.; Matinyan, S. G. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: 143-55(Jan 1971). (In Russian).

High energy dd scattering is considered taking into account the particle beam production at rescattering of nucleons contained in deuterons. Different inelastic contributions to the dd-scattering total cross section are analyzed. Energy dependence of the correction due to inelastic screening in hadron-deuteron scattering in the wide energy region is considered on the basis of the duality hypothesis. (auth)

22848 LIKELIHOOD HANDLING OF SCATTERING DATA WITH PREVIOUS EXPERIMENTAL INFORMATION. Bystricky,

J. (CEN, Saclay, France); Lehar, F.; Silin, I. N. Nuovo Cim.; 1A: 601-18(21 Feb 1971).

A modification of the maximum-likelihood method is given for the case where there exists previously known experimental information. This method is widely applicable for the handling of data from experiments where the scattering of particles is measured with the help of track detectors. The errors of calculated parameters are derived, and the question of sufficiency of experimental information is discussed. The goodness of fit of experimental data is treated, and an illustrative example is given concerning a scattering polarization experiment using spark chambers. (auth)

22849 DETERMINATION OF THE POTENTIAL WELL DEPTH FOR A Λ IN HEAVY HYPERNUCLEI. Deloff, A. (Univ., Warsaw). Nucl. Phys.; B27: 149-56(1971).

The problem of the binding energy of a Λ-particle in a potential well representing a heavy hypernucleus is considered. The exact solution of the Schrödinger equation with a potential of a Fermi (Saxon–Woods) shape is obtained. Also discussed are uncertainties in the well-depth parameter D and the extrapolation from nuclear matter to light hypernuclei. The shape dependence of the well is examined. (auth)

22850 GLAUBER'S MULTIPLE SCATTERING SERIES FOR NUCLEI IN THE PRESENCE OF SHORT RANGE CORRELATIONS. Huefner, Jeorg (Univ., Heidelberg. Max-Planck Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; B27: 260-8(1971).

Using the eikonal expansion of Sugar and Blankenbecler, the conditions under which Glauber's multiple scattering formalism may be applied to nuclei are investigated. If no information about nuclear pair correlations is to be extracted from the experiment, the momentum k of the projectile is restricted by $kR \gg 1$, where R is the nuclear radius. The angular range is found to include the domain of single and double scattering and thus is considerably larger than the usually stated limit of $\theta^2 \ll (kR)^{-1}$. Pair correlations of dimensions r_c can be determined only if $kr_c \gg 1$. Furthermore, only those correlations can be extracted reliably for which r_c is larger than the range of the projectile-nucleon interaction. (auth)

22851 UNITARITY CONSTRAINTS ON HELICITY-FLIP AMPLITUDES IN NUCLEON–NUCLEON SCATTERING. Muetter, K. H. (CERN, Geneva). Nucl. Phys.; B27: 73-6(1971).

From direct-channel unitarity upper bounds are derived on the pomeron contributions to the NN → NN helicity-flip amplitudes in terms of the non-flip amplitudes. (auth)

22852 UNCORRELATED JET MODEL FOR PARTICLE SPECTRA AND ELASTIC PROTON–PROTON SCATTERING AT VERY HIGH ENERGY. De Groot, E. H. (Univ. of Amsterdam); Ruijgrok, Th. W. Nucl. Phys.; B27: 45-63(1971).

Assuming that the particles produced in a high-energy collision are uncorrelated, except for energy and momentum conservation. A very simple formula is derived which exhibits the energy dependence of the relevant phase-space integral. Using this result it is a simple matter to derive the magnitude and the energy dependence of the average multiplicity and the total inelastic cross section. A relation between these two quantities is established and compared with the prediction of Feynman's parton model. A few single-particle spectra are calculated and compared with experiment. Choosing a simple form for the phases of the nucleon and meson wavefunctions the overlap function and hence the diffraction peak for elastic proton-proton scattering are calculated. In addition to the well-known effect of the meson phase it is also found that the nucleon phase has a considerable influence on the form of the diffraction peak. (auth)

22853 PHENOMENOLOGICAL ANALYSIS OF PROTON–PROTON SCATTERING FROM 50 TO 100 MeV. Chastel, Arnaud (Faculte des Sciences, Orsay, France). Nucl. Phys., B26: 269-303(1971).

A relativistic theory of the reaction pp → pp from 50 to 1000 MeV is given. The usual meson-exchange theory (π, η, ρ, σ, ω, φ) is taken as a left-hand cut of the Mandelstam plane. At these energies the only important channels are pp → pp, pp → NNπ and pp → dπ. The right-hand cut contribution is computed taking into account certain terms in the branching matrix. The corresponding N/D inelastic equations are solved. The agreement with experimental results is reasonably good. Thus this theory now gives a firm basis to re-evaluate the parameters of the left-hand cut. (auth)

22854 SPHERICALLY SYMMETRIC POTENTIALS FOR LOW-ENERGY n–p SCATTERING. Magyari, E. (Univ., Craiova, Romania). Stud. Cercet. Fiz.; 22: 945-52(1970). (In Rumanian).

By using the Agranovch–Marchenko approach to the inverse scattering problem, spherically symmetric potentials are constructed which allow one to describe low-energy neutron–proton interactions in the singlet and triplet states, respectively. As input data for the inverse scattering problem the experimental values of the scattering length and effective range are used. A family of potentials is obtained for the triplet state n–p interaction, and a unique potential is selected out by using experimental information about the cross section of deuteron photodisintegration. auth)

22855 DUALITY VS s-CHANNEL HELICITY CONSERVATION IN DIFFRACTION DISSOCIATION. Satz, H.; Schilling, K. (CERN, Geneva). Lett. Nuovo Cim.; 1: 351-4(27 Feb 1971).

It is shown that in its usual form the Reggeized multiperipheral matrix element is not compatible with s-channel helicity conservation. The reaction $p + p \to p + n + \pi^+$ with the pomeron and pion as the dominant exchanges is considered. (J.F.P.)

Particle Invariance Principles and Symmetries

Refer also to abstract 23281.

General

Refer also to abstract 22654.

22856 (BNL-50261) SYMMETRY PRINCIPLES IN PHYSICS. Lee, T. D. (Columbia Univ., New York). May 1970. 19p. Dep. NTIS.

In this lecture symmetry operations are reviewed, and their foundations examined. Nonobservables, symmetry transformations and conservation laws, asymmetries and observables, time reversal, complementarity of symmetry violations, and aesthetical considerations are covered. (J.F.P.)

22857 (JINR-E2-5599) SU(3) SYMMETRY AND STATISTICAL MODEL FOR MULTIPLE PARTICLE PRODUCTION. Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 10p. Dep. NTIS (U. S. Sales Only).

A simple method of parametrization of the SU(3) group is suggested. The projection of a physical state, containing an arbitrary number of octets and decuplets is represented by an integral over the parameter space of the symmetry group. (auth)

22858 SCALING SYMMETRY OF SCATTERING AMPLITUDES. Daboul, Jamil (Temple Univ., Philadelphia). Phys. Rev., D; 3: 1156-61(1 Mar 1971).

A possible symmetry relation among the scattering amplitudes of two reactions whose corresponding masses are related by a common factor $\sigma(m_i'/m_i = \sigma$ for all i) is introduced and studied. Two major physical examples of this symmetry involving electromagnetic and weak interactions are discussed. The possibility of this symmetry in strong interactions at high energies is considered and from it interesting predictions on the asymptotic behavior of cross sections are deduced. (auth)

22859 BOOST-BASIS FOR KINEMATICAL ANALYSES. Braathen, Hans J. (Univ. of Oslo). Nucl. Phys.; B27: 237-59(1971).

A basis is defined in which the generator of Lorentz-transformations along the z-axis is diagonal together with two components of the momentum and a suitable spin algebra element. The basis is introduced to facilitate the application boost operators in kinematical arguments. The Poincaré algebra is represented in this basis, and the connection with other bases like the helicity basis, and the one introduced by Kotański, is given. Some rather unusual hermitian operators are introduced and discussed. (auth)

22860 COMPLEX HELICITY AND THE SOMMERFELD–WATSON TRANSFORMATION OF GROUP-THEORETIC EXPANSIONS. Goddard, P.; White, A. R. (Cambridge Univ., Eng.). Nuovo Cim.; 1A: 645-79(21 Feb 1971).

The connection of group-theoretic expansions (in both continuous and discrete bases) of a function defined on SO_3 and $SO_{2,1}$ and analytic on their complexification (except for certain singularities), is discussed. This is achieved by making various transformations of the Sommerfeld–Watson type. The analyticity assumptions needed for these transformations are considered and found to depend on the basis chosen for the representation functions. The applications of this work to multi-Reggeon expansions and, in

particular, to the behavior of Reggeon vertex functions are discussed. The connections between the various Sommerfeld–Watson and group-theoretic signatures are also given. As a preliminary, transforms are used to relate the Fourier series to the Fourier integral. (auth)

22861 MATRIX ELEMENTS OF GENERATORS OF THE GROUP U(3) x U(3) IN A U(3) BASIS. Chacon, E. (Univ. Nacional de Mexico, Mexico City); Colon Vela, M. Rev. Mex. Fis.; 19: 277-96(1970).

The group U(3) × U(3) has recently become of importance in elementary particle physics. The relevant irreducible representations of this group are labeled by four nonnegative integer numbers $[b_1'b_2'][b_2'b_4']$, and its physically significant basis states are classified by a chain of groups U(3) ⊃ U(2) ⊃ U(1). It is known that this classification scheme involves a "multiplicity problem", but when $b_4' = 0$ this problem does not arise. The matrix elements of the generators of U(3) × U(3) with respect to the previously mentioned basis states, are determined with restriction to those irreducible representations with $b_4' = 0$. Also a brief discussion is given of the representation coefficients of U(3) × U(3). (auth)

22862 GENERAL TRANSFORMATION BRACKETS FOR HARMONIC OSCILLATOR STATES. Kramer, P. (Comision Nacional de Energia Nuclear, Mexico City). Rev. Mex. Fis.; 19: 241-52 (1970).

Certain reduced Wigner coefficients of the unitary group U(3) are explicitly obtained and used to derive the general transformation bracket for two-particle harmonic oscillator states in a closed form. The result admits a generalization to more than two particles. (auth)

22863 MASS FORMULAS IN THE ALGEBRAIC REALIZATION OF THE SU(3) SYMMETRY. Ogievetskii, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 187-97 (Jan 1971).

The algebraic realization of the SU(3) symmetry is considered. The mass sum rules were obtained, one of which is the Gell–Mann–Okubo formula. The necessity of nonets was proved in the case when Σ, Λ or π, η states are nondegenerate. The mass formulas obtained are satisfied with high accuracy for the satisfactorily established supermultiplets and give new predictions for nonets in which not all members are presently established. (auth)

Applications (Electromagnetic and Weak)

22864 CP VIOLATION AND REGENERATED K_{e3}^0 DECAY. Strovink, Mark William. Princeton, N. J.; Princeton Univ. (1970). 112p. University Microfilms Order No. 71-1634.

Thesis.

With a wire-spark-chamber spectrometer, about 287,000 K_{e3} decays downstream of a 9.125-inch Cu regenerator were reconstructed. The observed asymmetry between e^+ and e^- events was normalized by a corresponding sample of free decay data. The regeneration phase in Cu at a mean momentum of 2.2 GeV/c was found to be $\arg\{i(f-\bar{f})\} = -53.5° \pm 8.3° - 149°(|\delta| - 0.468)$ with δ the $K_1^0 - K_2^0$ mass difference in units of the K_1^0 decay rate. This value includes a correction of $-10.8 \pm 4.6°$ for the effect of diffractive and inelastic regeneration. By a unique method, this correction largely was determined from the data itself. Combination of part of the K_{e3} data with existing $K_{\pi 2}$ results has given, for the phase of the CP-violating amplitude ratio η_{+-}, $\phi_{+-} = 43.1° \pm 10.9°$ in agreement with the "vacuum regeneration" measurements. The relation between the observed amplitude of the K_{e3} asymmetry and the $\Delta S = \Delta Q$ selection rule also was examined. (Diss. Abstr. Int., B)

22865 CHIRAL $SU_3 \times SU_3$ BREAKING AND K_{l3} DECAY. Gomberoff, L.; Grossman, Z. (Tel-Aviv Univ., Israel). Nuovo Cim.; 1A: 566-70(1 Feb 1970).

K_{l3} decay is discussed in connection with the GOR model. The constant c is evaluated without assuming PCAC for K-mesons in the usual sense. The analysis done on the K_{l3} form factors indicates agreement with $\xi(t) \simeq -1$ in the physical region. (auth)

22866 SU(3) STRUCTURE OF ELECTROMAGNETIC CURRENT AND THE NEUTRAL VECTOR-MESON PHOTOPRODUCTION ON NUCLEONS. Rekalo, M. P. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: 139-42(Jan 1971). (In Russian).

The quark model for the neutral vector-meson photoproduction on nucleons is generalized to the case when the electromagnetic current contains the SU(3)-singlet component besides the octet component. Relations between the differential cross sections for processes $\gamma + N \to N + V^0$ ($V^0 = \rho, \omega, \varphi$) are found to be rather sensitive to contribution from the singlet component. Analysis of the experimental data on the reactions $\gamma + N \to N + V^0$, available now, indicates that the singlet component of the electromagnetic current is essentially less than the octet one. (auth)

22867 CP, $I = \frac{1}{2}$ RULE AND $K_{3\pi}$ DECAY. Cheng-cheung, Fei-shian (St. John's Univ., Jamaica, N. Y.). Nuovo Cim.; 1A: 706-16(21 Feb 1971).

The slopes are derived for the distribution of unlike and like pion energy spectra from squared matrix element. The application of the newest data to the relevant formula enables one to conclude that CP is conserved in both the I = 1 and I = 2 states; therefore data of $K_{3\pi}$ are consistent with the data of $|\eta_{00}| \simeq |\eta_{+-}|$, so CP violation comes only from the composition of K_2^0 and K_1^0. Also the prediction of $\gamma_2^{(\pm 0)}/\gamma_1^{(\pm 0)} \simeq 10^{-6}$ if the I = 2 state is zero and $\simeq 10^{-3}$ if the I = 2 state exists is presented. (auth)

Applications (Strong)

22868 (CALT-68-295) DILATION WIDTH, TENSOR-MESON DOMINANCE, AND BROKEN CONFORMAL INVARIANCE. Crewther, R. J. (California Inst. of Tech., Pasadena). [1971]. Contract AT(11-1)-68. 10p. (CONF-710106-2). Dep. NTIS.

From Conference on Fundamental Interactions at High Energy; Coral Gables, Fla. (20 Jan 1971).

The theory of the spontaneous breakdown of conformal and chiral symmetry is summarized. Conformal and chiral symmetry and collinear dispersion relations are discussed. It is concluded that the assumption of spontaneous violation of scale invariance does not conflict with the properties of the scalar meson σ in the range of mass from 500 to 800 MeV. (J.F.P.)

22869 DO PRESENT MESON BARYON SCATTERING DATA REALLY SUPPORT (3,3) + (3,3) DOMINANCE IN SU(3) x SU(3) SYMMETRY BREAKING. Kleinert, H. (Freie Univ., Berlin); Steiner, F.; Weisz, P. Phys. Lett.; 34B: 312-16(1 Mar 1971).

A general analysis is presented of the hypothesis that SU(3) × SU(3) is broken by terms in the Hamiltonian transforming according to $(\bar{3},3) + (3,\bar{3})$ and (8,1) + (1,8). It is shown that the popular assumption of dominance of $(\bar{3},3) + (3,\bar{3})$ cannot be confirmed as yet because of the scarceness of experimental data and the uncertainties in the off-mass shell continuation involved. (auth)

22870 TRANSFORMATION PROPERTIES OF HADRONS UNDER BROKEN CHIRAL SYMMETRY. Fuchs, N. H. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Nuovo Cim.; 1A: 553-65(1 Feb 1970).

The strong interactions are assumed to be approximately invariant under the group $SU_3 \otimes SU_3$, the symmetry breaking being given by a term transforming according to the (3,3*) and (3*,3) representation of this group. Since the vacuum is not an invariant, the hadrons transform irreducibly (approximately) according to a subgroup, which is assumed to be SU_3 times a discrete symmetry, as suggested by Dashen. Various aspects of symmetry breaking are discussed in detail, including configuration mixing, mass shifts due to $SU_3 \otimes SU_3$ symmetry reducing to SU_3, mass formulas and parity doublets. (auth)

22871 TESTS OF SOFT-MESON THEOREMS AND SU_3 X SU_3 SYMMETRY BREAKING. Gensini, P. (Univ., Lecce, Italy). Lett. Nuovo Cim.; 1: 273-6(13 Feb 1971).

Results from a slightly different approach to dispersive corrections to soft-meson theorems are discussed. Exact sum rules directly derived from SU(3) × SU(3) charge algebra for the absorptive part of the axial divergence—axial divergence correlation function taken between two baryon states are considered. The numerical results are given for various meson–baryon elastic interactions. Attention is given to the conclusions which can be inferred on the σ terms and on the nature of SU(3) × SU(3) symmetry breaking. It is found that a symmetry breaking behaving as a pure (1,8) + (8,1) representation of SU(3) × SU(3) can be rejected. (J.F.P.)

Field Theories

General

22872 DIVERGENCE DIFFICULTIES IN LOCAL FIELD THEORY. Taguchi, Yukio (Univ. of Osaka Prefecture, Sakai, Japan); Yamamoto, Kunio. Progr. Theor. Phys. (Kyoto); 44: 1698-9(Dec 1970).

A simple model is used to investigate the cause of the appearance of divergent quantities in local field theory. It is found that

these divergences are apparent ones coming out only in the course of calculations and have nothing to do with the defect of the local field theory itself. (J.F.P.)

22873 NEW CLASS OF ELECTROMAGNETIC FIELDS. Misra, R. M.; Pandey, Deo Bhushan (Univ. of Gorakhpur, India). Curr. Sci. (India); 40: 100-1(5 Mar 1971).

A procedure is discussed by which one can generate a new class of electromagnetic fields, which are not of the Weyl type, from a given axially symmetric vacuum gravitational field. The theorem is established that for every static vacuum gravitational field with axial symmetry there corresponds a solution of the combined Maxwell–Einstein equations which does not belong to the Weyl class of electromagnetic solutions. (J.F.P.)

22874 NEW FLUID PICTURE OF THE ELECTROMAGNETIC FIELDS IN POTENTIAL-REPRESENTATION USING THE RAPIDITY VECTORS. Yamasaki, Hisaiti (Kyusyu Dental Coll., Kitakyusyu, Japan). Progr. Theor. Phys. (Kyoto); 44: 1567-79(Dec 1970).

The form of existence of the classical electromagnetic field caused by electric charge is studied in terms of a Lorentz-invariant density ${}^0\varphi$ of the 4-potential and its rapidity vector V. This leads to a new fluid picture of the field which can reveal the simple mechanism underlying the fundamental electromagnetic phenomena. The fluid plays the role of the so-called ether or the medium of the classical electromagnetic wave corresponding to the acceleration field. The free electromagnetic field in empty space or the pure radiation may be visualized as the propagation of coupled vibration of positive and negative fluids $\pm{}^0\varphi^{free}$ similar to the above fluid. This wave travels through empty space, since the sum of $\pm{}^0\varphi^{free}$ reduces to zero or "vacuum," and the wave is composed of the vibration around the balanced state of "vacuum." (auth)

22875 INTERACTIONS IN THE WAVE EQUATIONS OF PARTICLES WITH SPIN. Jolivet, Andre (Univ., Angers, France). Ann. Inst. Henri Poincare, Sect. A; 13: 345-62(1970). (In French).

A study is made of systems of linear partial differential equations of finite rank, invariant with respect to the proper orthochronous Lorentz group and describing particles with spin interacting with macroscopic fields. (France)

Quantum Field Theory

Refer also to abstracts 22706, 22716, and 22796.

22876 (ITF-70-66-E) FIELDS AND LOCAL OBSERVABLES IN THE AXIOMATIC ALGEBRAIC THEORY WITH SUPERSELECTION RULES. Khoruzhii, S. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 24p. Dep. NTIS (U. S. Sales Only).

The new algebraic theory of superselection rules proposed recently is applied to the problem of constructing field quantities from local observables. The structure of the set of vectors analytic for the energy is described in detail and the cyclic and separating vectors of different algebras of local (global) observables are found. The physical equivalence of coherent superselection sections is proved and a number of the necessary and sufficient conditions of their local unitary equivalence is obtained. The conditions of the duality theorem are investigated as well as the relation between the duality and local unitary equivalence properties. The results obtained are compared with a previous treatment of the problem. (auth)

22877 (ITF-70-79) ON THE AXIOMATIC PROOF OF THE ASYMPTOTICAL RELATIONS FOR THE AVERAGED AMPLITUDE. Sabad, E. P.; Lomsadze, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 20p. Dep. NTIS (U. S. Sales Only).

There is continued the realization of the general program of obtaining the physical corollaries of the axiomatic approach without any a priori purely mathematical postulating of the class of the used generalized functions. A strict definition of the averaged asymptotic amplitude $\overline{T}_+(\omega', t')$ is given and it is proven that because of the microcausality it satisfies all the conditions of the Phragmen–Lindelöf–Nevanlinna generalized maximum principle in the upper ω halfplane and on the bound, and, consequently, all the theorems of the type Pomeranchuk's theorem must be fulfilled for it under corresponding conditions on the real axis. (auth)

22878 BREAKDOWN OF THE INVARIANCE SYMMETRY OF THE VACUUM IN QUANTUM FIELD THEORY. Grib, A. A.; Damaskinskii, E. V.; Maksimov, V. M. (Leningrad State Univ.). Usp. Fiz. Nauk; 102: 587-620(Dec 1970). (In Russian).

A range of questions were examined, which were connected to the problem of symmetry breakdown in quantum field theory, both in many-body theory and in the relativistic theory of elementary particles. The spontaneous breakdown of symmetry, dependent on the noninvariance of the vacuum (the primary state) invariant Hamiltonian, and the distinction of this type of breakdown from the usual, dependent on the presence of noninvariant terms in the Hamiltonian, were also examined. The proofs of the Coleman theorem concerning the relation of the Hamiltonian invariance with the vacuum invariance and the Goldstone theorem concerning the relation of the spontaneous breakdown of symmetry with the presence of a massless particle were given. Also given was the modified formulation of the Goldstone theorem showing that the massless particle, which exists upon the spontaneous breakdown of symmetry, can acquire mass in stages with the spontaneous breakdown of symmetry. The characteristics of the spontaneous breakdown of symmetry are illustrated using as an example Heisenberg ferromagnets and the theories of superfluidity in the nonrelativistic region and the Nambu and Jona–Lasinio and Goldstone models in the relativistic region. The main characteristics of a number of other models were briefly examined. The spontaneous symmetry breakdown relation with the existence of a classical macroscopic parameter, corresponding to such a symmetry breakdown, is indicated. In connection with the problem of the interpretation of the classical parameter in relativistic theory, the characteristics of field quantization in nonstationary space were given. (tr-auth)

22879 REDETERMINATION OF THE FINE-STRUCTURE CONSTANT BY MICROWAVE TRANSITIONS IN H, n = 2. Vorburger, Theodore Vincent. New Haven; Yale Univ. (1969). 108p. University Microfilms Order No. 70-16,575.

Thesis.

The $\Delta E - S$, the $2^2S_{\frac{1}{2}} - 2^2P_{\frac{1}{2}}$ splitting in H, n = 2, was remeasured. A beam of atoms is produced having a single hyperfine component of the $2^2S_{\frac{1}{2}}$, $m_j = -\frac{1}{2}$ metastable level. The beam then travels along the axis of a Helmholtz coil and is subjected to an electric field of microwave frequency perpendicular to this magnetic field. rf transitions are induced at a magnetic field of ~400 G to the $2^2P_{\frac{1}{2}}$, $m_j = +\frac{1}{2}$ level at a frequency of 10 840 MHz or to the $2^2P_{\frac{1}{2}}$, $m_j = -\frac{1}{2}$ level at a frequency of 9400 MHz. Determinations of the resonant field for each hyperfine component of each fine structure transition yield four independent values of $\Delta E - S$. The final weighted average is 9911.165 ± .042 MHz. The recent determination of the Lamb shift S by Robiscoe is added to give a value for the fine structure splitting ΔE. This yields a value of the fine structure constant $\alpha^{-1} = 137.0358$ (5). (Diss. Abstr. Int., B)

22880 SUGAWARA'S CURRENT THEORY AND CHIRAL LAGRANGIAN THEORY. Hosoya, Akio (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 44: 1673-83(Dec 1970).

On the basis of Sugawara's current algebraic postulates, a quantum field theory, whereby the axial current is expressed in terms of the vector current and a pseudoscalar field is constructed. A definite form of energy momentum tensor and $C = f_\pi^2$ for the coefficient of Schwinger's term is found. It is also shown that a conventional chiral effective Lagrangian gives the same expression for energy momentum tensor as the one derived from Sugawara's current theory, provided that a certain limiting procedure is applied to the former case. (auth)

22881 GENERALIZATION OF METRIC TENSOR AND ITS APPLICATION. Perng, J. J. (National Taiwan Univ., Taipei). Ann. Inst. Henri Poincare, Sect. A; 13: 287-93(1970).

The definition of a metric tensor and the well known Ricci theorem are modified. The Einstein tensor and Maxwell equations are generalized. The field equations of gravitation and electricity are unified. The introduction of a metric in the space with symmetric connection is defined. (France)

22882 MECANIQUE QUANTIQUE (PARTICULE DANS UN CHAMP). TOME I. EQUATION DE SCHROEDINGER. (Quantum Mechanics (Particle in a Field). Volume I. The Schroedinger Equation). Paris; Masson et Cie, Editeurs (1970). 676p.

The behavior of a particle in a field is studied. The data for the problem are potential energy when a neutral particle is considered and electromagnetic potentials when charged particles are considered. The information obtainable, when the Schrödinger equation is used to describe the particle, is discussed. This equation is only a first approximation since it does not possess relativistic symmetry and ignores the spin of the particles. (France)

22883 GROUND STATE OF THE HARMONIC OSCILLATOR AS A LIMITING CYCLE. Surdin, M. (Bordeaux Univ., Talence,

France). Ann. Inst. Henri Poincare, Sect. A; 13: 363-70(1970). (In French).

It is shown that the action of the zero Wheeler and Feynman field on a harmonic oscillator leads to a limiting cycle. This limiting cycle is not incompatible with the fundamental state of a harmonic oscillator. (France)

22884 CONTRIBUTION TO THE STUDY OF THE YANG–MILLS FIELD. Kerbrat-Lunc, Helene. Ann. Inst. Henri Poincare, Sect. A; 13: 295-343(1970). (In French).

The fundamental mathematical definitions in the Yang and Mills field theory are recalled. The notion of invariant derivatives is extended to the field variables. The law for the infinitesimal transformation of the field components is given. Three particular cases are considered: the Yang–Mills field with a curved space-time, the field associated with a Weyl group and the field associated with a conformal group. Some particular solutions of the Yang–Mills field equations are given. (France)

22885 FIELD DIMENSION AND GRAVITATIONAL VERTEX. Kleinert, H. (Freie Univ., Berlin); Weisz, P. H. Nucl. Phys.; B27: 23-32(1971).

The implications of the dimension of a field on its gravitational vertex function are discussed. As expected from the LSZ theory, the dimension as an intrinsic property of the interpolating field does not enter into on-mass-shell quantities. Thus, contrary to the claim of Kastrup, the slope of the scalar form factor is not determined by the dimension of the field. Only under additional assumptions involving the dimension of the SU(2) × SU(2) breaking is such a determination possible. (auth)

22886 ZERO-MASS SUPERPROPAGATOR. Blomer, R. J. (American Univ., Beirut); Constantinescu, F. Nucl. Phys.; B27: 173-92(1971).

A rigorous construction for the zero-mass exponential superpropagator is given. It is based on an explicit regularization of the propagator in coordinate space and a suitable choice of the coupling constant is taken in order to damp down the regularized superpropagator to an L^2 function. By applying a Sommerfeld–Watson transformation and a Fourier transformation it is shown that the regularized superpropagator tends, in an appropriate sense, both in momentum and coordinate space, to some localizable generalized function. Analytic continuation in the coupling constant shows the appearance of a logarithmic cut. By means of the regularization of the propagator and the special choice of the coupling constant it is not necessary to cut divergent integrals nor to pass to Euclidean region. Extensions to superpropagators which are formally written as entire functions of the propagator are given. (auth)

22887 EQUAL-TIME LIMITS OF ANTICOMMUTATORS IN RELATIVISTIC THEORIES. Wreszinski, W. F. (Univ., Sao Paulo, Brazil). Nuovo Cim.; 1A: 691-705(21 Feb 1971).

The structure of anticommutators between interacting fermion fields in the equal-time limit (e.t.l.) is investigated in relativistic models in two-dimensional space-time, mainly as regards q-number Schwinger terms, following similar investigations in perturbation theory and in nonrelativistic models. Essentially, it is found that, typically, there exists a critical coupling constant below which the e.t.l. of the anticommutator minus the c-number vacuum expectation value (v.e.v.) contribution is zero, and above which it is not well defined as an operator-valued distribution. For the critical value of the coupling constant, the coefficient of the q-number term is proportional to a delta-function in the e.t.l. Two types of definitions of e.t.l. are briefly compared. (auth)

22888 QUANTUM FIELD THEORY OFF NULL PLANES. Neville, R. A.; Rohrlich, F. (Syracuse Univ., N. Y.). Nuovo Cim.; 1A: 625-44(21 Feb 1971).

The initial-value problem for hyperbolic differential equations with the initial data given on a null plane in Minkowski space is considered in detail for the Klein–Gordon and Dirac equations. Existence and uniqueness theorems are given. The quantum field-theoretic analog involves the commutation relations on the null plane and the null translation operator off that plane. The formal theory of interacting fields is stated briefly in the Feynman–Dyson spirit. It is pointed out that an interaction that involves the null co-ordinate derivative of the field in the direction off the initial plane leads to additional complications. (auth)

22889 LOCAL QUANTUM THEORIES APPLIED TO THE STUDY OF PARTICLE COLLISIONS. Angelescu, N. (Inst. of Nuclear Physics, Bucharest). Stud. Cercet. Fiz.; 22: 1055-96 (1970). (In Rumanian).

Some of the results so far obtained in the description of collisions processes in the framework of the Wightman and Araki–Haag local quantum theories are summarized. Before the postulates of these theories are presented, the quantization of the free field is briefly reviewed. Then, the existence of the collision states is proved and the asymptotic behavior of the time-translated quasilocal operators is studied. This makes possible a description of spatially localized particles in collision states, as well as writing down the cross sections by using only the quasi-local observables of the physical system under consideration. (auth)

22890 TACHYON PHOTONS IN FRESNEL'S EVANESCENT WAVE. Costa de Beauregard, O. (Institut Henri Poincare, Paris). Lett. Nuovo Cim.; 1: 305-6(13 Feb 1971).

The light quanta associated with the Fresnel evanescent wave in total reflection behave in some essential respects as tachyon photons, the imaginary momentum component entailing consequences analogous to those of the imaginary proper mass of tachyons proper. The hyperfine transitions of atoms in a beam are considered. (J.F.P.)

22891 THE ZERO-MASS LIMIT AND RENORMALIZABILITY IN THE THEORY OF MASSIVE YANG–MILLS FIELD. Vainshtein, A. I.; Khriplovich, I. B. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 13: 198-211(Jan 1971). (In Russian).

It is shown that in framework of the perturbation theory for the massive Yang–Mills field no zero-mass limit exists, and the theory is nonrenormalizable. These results are due to the singularity of interaction of the zero-helicity (space-longitudinal) quanta, that is absent for the neutral vector field. A formalism is constructed that is a generalization of the radiation gauge to the nonzero-mass case, where the interaction of the space-longitudinal quanta is represented explicitly. Considering the problem in this formalism one concludes that the continuous zero-mass limit likely exists and the theory may be renormalizable beyond the perturbation theory approach. (auth)

22892 ANALYTIC REGULARIZATION IN QUANTUM FIELD THEORY. Guerra, F. (Inst. for Theoretical Physics, Kiev. Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples). Nuovo Cim.; 1A: 523-35(1 Feb 1970).

The singularities on the complex plane of λ's of the distributions $[(\xi_1-\xi_2)^2-i0^+)]^{\lambda_{12}}\cdot[(\xi_1-\xi_3)^2-i0^+]^{\lambda_{13}}\cdot\ldots\cdot[(\xi_{n-1}-\xi_n)^2-i0^+]^{\lambda_{n-1n}}$ are investigated in the framework of the method of analytic regularization in configuration space. (auth)

22893 TIME MEASUREMENT: CRITICISM OF A PAPER BY L. M. STEPHENSON. McCrea, W. H. (Univ. of Sussex, Brighton, Eng.). J. Phys., A (London); 4: L8-14(Jan 1971).

A recent paper on time measurement by L. M. Stephenson (J. Phys. A. 3: 368-377(1970)) is examined in detail. It is argued that the paper sheds no new light on the subject and that it is altogether misleading. In particular, while the notion of a primary time scale in special relativity bears some relation to certain elements that are familiar and valid, Stephenson's own treatment of the notion appears to be wholly erroneous. (auth) (UK)

22894 COMMENTS ON THE PAPER TIME MEASUREMENT USING A REALIZABLE ATOMIC CLOCK. Strnad, J. (Univ. of Ljubljana, Yugoslavia). J. Phys., A (London); 4: L-6-8(Jan 1971).

A recent statement in connection with complete clocks is disputed and the traditional time dilatation of the special theory of relativity is upheld. (auth) (UK)

22895 NEW PARASTATISTICS IN FIELD THEORY. Kademova, K. V.; Kraev, M. M. (Inst. of Physics, Sofia). Nucl. Phys., B26: 342-8(1971).

It is shown that the para-quantization treatment of the harmonic oscillator requires a modification of the para-Fermi commutation relations. This leads to a new type of parastatistics which is characterized by a positive number $0 < p < \infty$. The representations of the modified para-Fermi commutation relations in Fock space are found and studied. (auth)

22896 ABOUT LORENTZ TRANSFORMATIONS AND TACHYONS. Olkhovskii, V. S. (Kiev State Univ.); Recami, E. Lett. Nuovo Cim.; 1: 165-8(23 Jan 1971).

It is pointed out that the usual velocity addition theorem can be univocally derived from the Lorentz transformations, and that this theorem must hold for all kinds of particles (braydyons, luxons and tachyons) independently of their real or unreal proper mass. There is formally a complete indistinguishability between the two sets of sub- and super-luminal frames. It follows that

for every particle a couple of quantities may correspond to each property of it as manifesting itself with regard to frames of the two worlds respectively. Thus every particle may be given a couple of proper masses, one for the first world and one for the second. Also conditions are shown under which a tachyon appears as an antitachyon. (J.F.P.)

22897 ASYMPTOTIC BEHAVIOUR OF SOME USEFUL INTEGRALS. Montaldi, E. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Lett. Nuovo Cim.; 1: 117-28(23 Jan 1971).

Some simple formulas are given which are very useful in investigating the asymptotic behavior of a fairly general class of integrals frequently occurring in connection with the use of dispersive techniques in quantum field theory. (J.F.P.)

Gravitation and General Relativity

Refer also to abstract 22713.

22898 RAUM–ZEIT–MATERIE. VORLESUNGEN UEBER ALLGEMEINE RELATIVITAETSTHEORIE. (Space–Time–Matter. Lectures About General Theory of Relativity). Weyl, Hermann. Berlin; Springer-Verlag (1970). 346p. $8.20.

A lecture series on Einstein's theory about space, time, and gravity is presented. After development of the concept of time, the Euclidian space is discussed with its mathematical formulation and the introduction of tensor-algebra and tensor-analysis. Then, the ideas are developed which transcend the Euclidian space and which find their final conclusion in the concept of the metric continuum and Riemann's space concept. Subsequently, the coupling between space and time in the universe is discussed. Finally, the ideas lead to Einstein's general theory of relativity which not only comprises gravity, but also electromagnetic phenomena. New concepts about matter are developed. (H.B.G.)

22899 ACTION-AT-A-DISTANCE THEORY OF GRAVITATION. Volkov, A. B. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: 201-17(15 Jan 1971).

An action-at-a-distance theory is formulated as a possible alternative to the general theory of relativity. The observed gravitational frequency shift and light bending are obtained by photon energy and momentum conservation effects and gravitational–electromagnetic phenomena are interpreted in analogy with the quantum theory of dielectric dispersion. The observed perihelion advance of Mercury is obtained by a combined scalar and vector interaction theory of the Wheeler–Feynman type. The vector interaction is no longer excluded by conventional field theoretic arguments. (auth) (Canada)

22900 SELECTIVE CHARACTER OF THE CATTANEO CONDITION. Fatton, Jacques. Compt. Rend., Ser. A; 271: 754-6 (12 Oct 1970). (In French).

The Cattaneo condition $\gamma^{p\xi}LL(\tilde{\gamma})\gamma_{p\xi} \equiv 0$ is analyzed. An example is used to demonstrate that its selective character is only apparent. (France)

22901 SUPPLEMENTARY EQUATIONS IN THE NEWMAN–PENROSE FORMALISM. Papapetrou, A. (Paris Univ.). Ann. Inst. Henri Poincare, Sect. A; 13: 271-86(1970). (In French).

If the Newman–Penrose equations are written in the form $(\ldots) = 0$, there are a number of identities satisfied by the left hand side of these equations. Using these identities the Newman–Penrose equations can be separated into principal, supplementary and trivial equations. The separation of these equations is given for a combined Einstein–Maxwell field. The identities are systematically studied. Three identities are deduced for the gravitational field and one for the electromagnetic field. (France)

22902 RADIATING LEVI–CIVITA METRIC. Rao, J. Krishna (King's Coll., London). J. Phys., A (London); 4: 17-20(Jan 1971).

A generalization of Levi–Civita's static solution for the exterior gravitational field of a cylinder of infinite length and finite cross section, corresponding to the field equations $T_{ab} = qk_ak_b$, $k_ak^a = 0$, is discussed. The expression for q is of the form $f'(u)/\rho$, which shows the typical cylindrical fall-off over the null hypersurface u = constant. It is pointed out that the passage of an outgoing wave affects permanently the static Levi–Civita space-time and the energy for this class of solutions is a particular case of the C-energy defined by Thorne. The geodesic equations for a test particle moving in the radial direction display a gravitational "induction field" which is associated with a changing mass in the Newtonian field and is directed towards the axis of the cylinder. In contrast with the spherically symmetric case the induction field always acts to decrease the energy of a test particle on which it acts. It is shown that the mass per unit length of the static cylinder strongly affects the shear and divergence of the null congruence. The asymptotic behavior of the Weyl tensor is analyzed and a peeling theorem proved for this case. (auth) (UK)

22903 PROBABILITY OF LONG-PERIOD GRAVITATIONAL RADIATION. Anderson, Allen Joel (Uppsala Univ.). Nature (London); 229: 547(19 Feb 1971).

In an attempt to support Weber's detection of gravitational waves a search was made of variations in the expected Doppler frequency of signals returning to earth from Mariner 6 or 7, while the spacecraft were at distances from the earth comparable with the wavelength of such long period gravitational radiation that might exist. Preliminary results are given. (UK)

22904 INDUCED TRANSPORT IN 5-DIMENSIONAL FIELD THEORY. Burghardt, R. (Reaktorzentrum, Seibersdorf, Austria). Acta Phys. Austr.; 29: 96-9(1969). (In German).

In a 5-dimensional Riemann space V_5 a transformation was induced by the parallel displacement of a vector in the embedded V_5^4. It is asymmetric and contains the electromagnetic field strengths. The motion equation of a charged particle in the gravitation and electromagnetic field was derived with help of the induced transformation from unified principle. (tr-auth)

Scattering Theory

Refer also to abstracts 22710, 22719, 22784, and 22877.

22905 REGGEONS AS ELECTRIC MULTIPOLES. Alessandrini, V. (CERN, Geneva. Univ., Geneva). Phys. Lett.; 34B: 304-8(1 Mar 1971).

A simple derivation of Lovelace's N-Reggeon vertex is given by associating a Reggeon with a charge distribution on the equator of a sphere. The vertex is simply the exponential of the Coulomb energy of the charge distributions, and the coherent state parameters that describe the Reggeons are their multipole moments. (auth)

22906 FUNCTIONAL INTEGRAL REPRESENTATION OF THE GREEN'S FUNCTION FOR THE NAMBU–MIYAMOTO EQUATION. Kobayashi, Tsunehiro; Shibasaki, Ichiro (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 44: 1709-11(Dec 1970).

The functional integral representation for the propagator, which is a Green function for the Nambu–Miyamoto proper-time equation, is proposed. Then application of the functional integral method to the renormalization problems is discussed, and a seriously bad divergence in each order of perturbation series of the Green function is found. A feature of the method is that the renormalization problem may be discussed without any expansion of the perturbation series. (J.F.P.)

22907 BEHAVIOR OF THE ELASTIC SCATTERING AMPLITUDE AT MOMENTUM TRANSFERS DECREASING AS $(\ln s)^{-2}$. Nguyen van Hieu (Joint Inst. for Nuclear Research, Moscow). Nucl. Phys., B26: 330-4(1971).

It is proven that in any interval $-4k^2 + t_1(s) \leq t \leq -t_1(s)$, where $t_1(s) = \text{const.}/\ln^2 s$, there must exist at least one value t_0 such that the magnitude of the elastic scattering amplitude at this momentum transfer has the same behavior as its behavior at $t = 0$: $|F(s,t_0)/F(s,0)| \gtrsim \text{const.}$, $s \to \infty$. This conclusion is true for the imaginary part of the amplitude. If the real part of the amplitude at $t = 0$ is bounded below by some power s^{-n}, then for real part there is also the same result. (auth)

22908 NON-REALATIVISTIC S-MATRIX THEORY EQUATIONS. Grashin, A. F. (Moscow Regional Pedagogical Inst.). Nucl. Phys., B26: 304-16(1971).

The complete system of equations of the nonrelativistic S-matrix theory is proposed, the system consisting of the Ekstein equations and new additional equations eliminating the ambiguity in the solution of the bilinear equations known earlier. General relations between various amplitudes are found with the help of the obtained equations. The two-particle case with a separable interaction is discussed as an example. (auth)

22909 INVERSE PROBLEM IN POTENTIAL SCATTERING. Magyari, E. (Univ., Craiova, Romania). Stud. Cercet. Fiz.; 22: 841-62(1970). (In Rumanian).

The inverse problem of the potential scattering is briefly reviewed. As input data the phase-shift δ_l, given for all positive

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energies is considered and the Gelfand–Levitan method of solving the inverse problem is outlined. A systematic investigation of the Gelfand–Levitan equation is made. Several remarks are made on criteria for choosing the comparative potential, on families of equivalent potentials, and a theorem is given on the existence of at least one S-wave bound-state. The compatibility of different inputs of the above kind is discussed. (auth)

22910 CHARACTER OF SINGULARITIES OF SOME ONE-LOOP NONRELATIVISTIC DIAGRAMS. Kuznetsov, G. I. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: 212-20(Jan 1971). (In Russian).

Analytical structure of some one-loop nonrelativistic diagrams is investigated using the methods of the homology theory. Homology groups are constructed, the character of singularities of the Landau surfaces is established and relations between absorptive parts for diagrams with 3 to 5 angles are found. (auth)

22911 EXPANSION OF THE SCATTERING AMPLITUDE ON THE GROUP O(4) FOR UNEQUAL MASSES. Zamiralov, V. S.; Shepelev, G. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: 513-16(Sep-Oct 1970). (In Russian).

The concept of an asymptotically small group 0(4) which may be used for describing the expansion of spiral amplitudes of the t-channel at unequal masses of external particles was introduced. The expansion was used for determining kinematic factors of spiral amplitudes in forward scattering at large energies. (R.V.J.)

Particle Accelerators

Refer also to abstracts 21302, 21414, 21470, and 22962.

22912 (LNF–70/48) ADONE DEVICE: PRESENT STATUS AND OPERATION. Note No. 493. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 22 Oct 1970. 14p. Dep. NTIS (U. S. Sales Only).

Starting December 10, 1969, Adone has been running for experiments with head-on collisions and beam energies up to 1200 MeV. Four experiments are running at a time. The present energy limitation is due to the fact that two of the four RF cavities have not been installed yet. Installation of full RF power is scheduled to begin at the end of this year or around February 1971. 1500 MeV beams will then be available. At the high energy side of the working range the design values of luminosity have been obtained. Operation data are tabulated. (auth)

22913 (LNF–70/50) FIELD AROUND COMPENSATOR MAGNETS IN ADONE BEAM-COLLIDING EXPERIMENT. Note No. 494. Carpenter, C. J.; Ratti, U. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 3 Nov 1970. 8p. Dep. NTIS (U. S. Sales Only).

The transverse field around the compensator magnets is plotted by assuming two-dimensional conditions, and the consequence of the approximations is examined. It is shown that the effect of the external field which is due to the projection of the compensator and windings produces an increase in compensator flux of more than 50%, and an even larger increase in the screening effect which the compensator has on the main flux. The flux intersecting different orbits through the magnets may vary by several percent, with similar components at right-angles to the main field and the orbit direction. A three-dimensional solution is recommended, and is entirely practicable in numerical terms. (auth)

22914 (LNF/AOR–1) ADONE OPERATION REPORT, JANUARY 1–DECEMBER 31, 1970. Placidi, M.; Cocco, G.; Vescovi, M.; (and others) (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 6p. Dep. NTIS.

Operation data are presented including machine time dedicated to high-energy physics, nuclear physics, machine physics, machine shutdowns for modifications, and maintenance time. Linac operation is summarized. (W.H.K.)

22915 (SJC–A–70–3) ELECTROPLATING OF PROTON LINEAR ACCELERATOR TANKS. Tanaka, J.; Nishikawa, T.; Baba, H.; Okumura, S. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Apr 1970. 11p. Dep. NTIS (U. S. Sales Only).

A method for electroplating copper on the accelerator tanks of a proton linac is described. Topics include copper-plating by ordinary acid copper bath, acid copper bath with brightening agent, copper deposition on the inner surface of steel cylinder, the influence of holes, plating on flanges with contacter grooves, Q value of copper plated test cavity, and a 1-meter long model accelerator tank. (W.H.K.)

22916 (SLAC-PUB–802) PRESENT STATUS AND FUTURE PLANS AT SLAC. Neal, R. B. (Stanford Linear Accelerator Center, Calif.). Nov 1970. 51p. (CONF-701120–1). Dep. NTIS.

From 2 national conference on particle accelerators; Moscow, USSR (11 Nov 1970).

The Stanford Linear Accelerator operations statistics are tabulated and recent accelerator improvements are outlined. Klystron experience and the status of the SPEAR (Stanford Positron–Electron Asymmetric Ring) are summarized. Future plans including higher power klystrons, possible improvements in duty cycle and beam energy, and the feasibility study for converting to a superconducting 100-GeV linac are discussed. The parameters of SPEAR and the parameters of a two-mile 100-GeV superconducting accelerator are listed. (W.H.K.)

22917 (UCRL–20230) LRL RACETRACK MICROTRON. Ruby, Lawrence; Rechen, Joseph B. (California Univ., Berkeley. Lawrence Radiation Lab.). 15 Dec 1970. Contract W-7405-eng-48. 15p. Dep. NTIS.

A racetrack microtron is described, which is patterned after a similar machine at the University of Western Ontario. The LRL microtron produces 10 mA peak currents at 60 pulses per second. Only modest shielding and air cooling are required. An external beam is either used directly or converted to bremsstrahlung. (auth)

22918 (UCRL-Trans–1426) STUDY OF THE NEGATIVE-MASS EFFECT IN THE "ADGEZATOR" MODEL. Ryltsev, P. I.; Sarantsev, V. P.; Fartushnyi, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from report JINR–P9-4620. 33p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 52044.

22919 PREPARATION OF THIN TUNGSTEN FOILS FOR NUCLEAR RESEARCH. Kovalenko, L. I.; Rosen, A. A. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 935(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 260(May-Jun 1970).

A procedure is described for producing thin (1-5 μ) tungsten foils by the vacuum thermal decomposition of WCl_6 on a molybdenum substrate. The procedure was developed for the production of foils of metal isotopes. (auth)

22920 AUTOMATIC CORRECTION OF THE SPATIAL POSITION OF A SECONDARY PARTICLE BEAM IN THE ACCELERATOR. Glagolev, V. V.; Eliseeva, I. A.; Lebedev, R. M.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 779-83(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 129-33(May-Jun 1970).

A system which indicates and automatically corrects the position of a secondary particle beam is described. A histogram of intensity distribution in the plane perpendicular to the beam axis is produced by an automatic recorder. The average deviation of the beam from the prescribed position under automatic correction is no greater than 2 or 3 mm. The apparatus is constructed of typical sampling circuits employed in nuclear electronics and computer technology. Experience with the system used with a liquid hydrogen bubble chamber is discussed. (auth)

22921 MAGNETO-OPTICAL CHANNEL FOR THE SEARCH FOR QUARKS. Aleksandrov, I. A.; Grachev, M. I.; Gubrienko, K. I.; (and others). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 738-40(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 95-8(May-Jun 1970).

A channel of negative particles which has a high aperture ratio $\approx 300\ \mu sr \cdot GeV/c$ is described. The optical scheme of the channel allows formation of beams of secondary particles having momenta up to 80 GeV/c with a sufficiently large momentum scatter of the particles (~15%) for good compensation of the angular and linear dispersions. The working characteristics of the channel are given, and the parameters of the beams of secondary particles are determined. (auth)

22922 INCREASE IN THE EFFICIENCY OF COLLECTING SECONDARY CHARGED PARTICLES IN ACCELERATING TUBES WITH OBLIQUE FIELDS. Serbinov, A. N.; Mazhulin, A. V.; Yakushev, V. P.; Lashuk, A. I.; Sadokhin, I. P. (Physics-Energy Inst., Obninsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 696-9(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 58-61(May-Jun 1970).

Methods of increasing the efficiency of collecting secondary

charged particles in accelerating tubes with oblique fields are described. The construction of the secondary particle traps is shown. The x-ray radiation spectra of two Eg-2.5 tubes are shown, one of which had collectors for secondary charged particles. (auth)

22923 CHARGE EXCHANGE OF PROTONS IN NEGATIVE IONS ON CESIUM. Khirnyi, Yu. M.; Kochemasova, L. N. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 693-5(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 56-8(May-Jun 1970).

It is shown that the maximum conversion from H_1^+ to H_1^- can be obtained on Cs. The measured charge exchange coefficient 0.26 ± 0.02 substantiates the conclusions drawn. (auth)

22924 EXTRACTION OF A BEAM FROM THE JOINT INSTITUTE FOR NUCLEAR RESEARCH TWO-METER ISOCHRONOUS HEAVY-ION CYCLOTRON BY THE CHARGE-EXCHANGE METHOD. Shelaev, I. A.; Alfeev, V. S.; Kozlov, S. I.; Oganesyan, R. Ts. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 689-92(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 53-6(May-Jun 1970).

A new method of extracting a beam of accelerated heavy ions by charge-exchange in a thin foil is described. Some experimental results relating to the extraction of D_2^+, He_4^+ and C_{12}^{+6} ions from the Joint Institute for Nuclear Research (JINR) two-meter isochronous cyclotron are presented. The extraction coefficient is approximately 100%. (auth)

22925 MEASUREMENT OF THE HIGH-FREQUENCY STRUCTURE OF THE BEAM OF AN ELECTRON SYNCHROTRON. Aleksanyan, A. S.; Bekker, B. I.; Pikhtelev, R. N.; Kheifets, S. A. (Erevan Physics Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 686-8(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 51-2(May-Jun 1970).

The results of measuring the high-frequency structure of a beam of electrons with the aid of a time spectrometer and the shift in equilibrium phase in the process of acceleration are described. The results are compared with calculations. (auth)

22926 MEASUREMENT OF THE PHASE CHARACTERISTICS OF THE BUNCHER IN A LINEAR ELECTRON ACCELERATOR. Ostrovskii, E. K.; Zykov, A. I. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 683-5 (May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 48-50(May-Jun 1970).

A method is proposed for measuring the phase characteristics of the buncher in an electron linear accelerator. The method is based on the probing of the buncher with monoenergetic groups of electrons having a small phase spread. As a means of measuring the output phase of electrons, a short section of diaphragmed waveguide excited with an HEM_p wave (particle separator) is employed. The results of measuring the phase characteristics of the buncher in a 40-MeV accelerator are presented. It is shown that the experimental relationships agree reasonably well with electron-dynamics calculations. (auth)

22927 SHAPING OF RECTANGULAR FIELD-PULSES IN INDUCTANCE-TYPE DRIVING MAGNET. Ratnikov, B. K. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 679-82(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 44-8(May-Jun 1970).

A circuit with nonlinear inductances is described that makes it possible to shape single rectangular steep pulses in an inductance-type driving magnet fed by a capacitor bank for a fast ejection system for synchrotron. Experimental data are presented, as well as the principal formulas for the selection of the circuit parameters. (auth)

22928 ACHROMATIZATION OF PARTICLE BEAMS FOR THE CASE IN WHICH THE MAGNETIC ANALYSIS PRECEDES THE LIMITING OF THE BEAM. Miller, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 675-8(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 42-4(May-Jun 1970).

If the analyzing magnet in the focusing system is situated ahead of the aperture collimator, then the usual conditions for achromatization ($D_X = D'_X = 0$) lead to a broadening of the beam in the output objective. A field lens mode is recommended for which a trajectory passing through the center of the aperture collimator is brought out into the system axis for each momentum $p = p_0 (1 + \delta)$. In this case the cross section of the beam in the output objective coincides with the cross section of the beam for the central momentum (in the linear approximation) for $\delta \neq 0$. (auth)

22929 CERTAIN TYPE OF MAGNETIC FOCUSING SYSTEM WITH COMPENSATED DISPERSION. Miller, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 672-4(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 39-41(May-Jun 1970).

The properties of magnetic systems in which the compensating magnet is situated at the end of the system and dispersion is eliminated in the final image and at the center of the output objective lens in which the beam has its largest width are analyzed. As in conventional achromatic systems, it is possible here to achieve good transport of the beam over a wide range of $\delta = \Delta p/p$. For the focusing sequences DFFFD and FDFDF the rotation angles α_i in the compensating magnet turn out to be different (by a factor of 3 or 4), and this allows easy switching of the beams from one installation to another in certain cases (having a beam with compensated dispersion in each direction), or it allows beams to be obtained with compensated or increased dispersion without intensity losses. (auth)

22930 SENSITIVITY OF THE METHOD OF SWITCHING OFF A SINGLE SECTION IN THE STRONG-FOCUSING CHANNEL OF A LINEAR ACCELERATOR. Batalin, V. A.; Kolomiets, A. A. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 670-1(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 37-9(May-Jun 1970).

Data were obtained on the sensitivity of the method of switching off a single section in the strong-focusing channel of a linear accelerator for the case of displacement of the magnetic axis of the quadrupole lens and deviation of the field gradient in it from the preset value. The measurement method is described. The results of the measurements of the parameters of the transverse motion for particles in the linear accelerator I-2, the injector of the proton synchrontron ITEF, are presented. (auth)

22931 INSTABILITY OF THE MOTION OF THE PARTICLES IN A SYNCHROTRON WITH STRONG FOCUSING AT HIGH FREQUENCIES OF THE ACCELERATING FIELD. Kheifets, S. A. (Erevan Physical Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 663-9(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 32-7(May-Jun 1970).

The results of an earlier paper are generalized for an axially-asymmetrical accelerator with strong coupling between the longitudinal and radial oscillations; instability occurs in the same way as in the axially-symmetrical case. In an accelerator with a magnetic field of alternating sign, regions of stability of the longitudinal and radial oscillations, in which the oscillations assume high frequencies, may develop. Instabilities occur, however, if certain inequalities are satisfied; these inequalities are derived, and the values of the parameters in the neighborhood of which the longitudinal and radial oscillations remain stable at the same time are also determined. (auth)

22932 ABERRATIONS IN ELECTROSTATIC PRISMS. Kel'man, V. M.; Rastorguev, V. A.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1131-7(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1467-75(Jul 1970).

The vertical and horizontal aberrations of an electrostatic prism operating in a prism-type charged-particle energy analyzer are studied. The vertical aberrations were shown to be of third order and the horizontal aberrations of fourth order. The corresponding aberration coefficients were calculated. In the general case, the spectral-line broadening is of fourth order. This broadening can be reduced materially by selecting the source shape. The prism parameters at which such a decrease in linewidth is achieved without distortion of the source are determined. (auth)

22933 FOUR-ELECTRODE DEFLECTING TELESCOPE SYSTEMS. I. PARAXIAL PROPERTIES. Kel'man, V. M.; Rastorguev, V. A.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1125-30(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1458-66(Jul 1970).

A theoretical investigation of four-electrode deflecting telescope systems in the paraxial approximation is described. Each electrode of the system consists of a pair of parallel plates arranged symmetrically with respect to the median plane. The results are presented in the form of curves which make it possible to determine the potential ratios at the electrodes necessary for telescope action, to find the path of the refracted charged-particle beam (which initially moves parallel to the median plane), and to plot the trajectory of this beam within the field. (auth)

22934 GEOMETRIC AND CHROMATIC ABERRATIONS IN THREE-ELECTRODE TELESCOPE SYSTEMS. Kel'man, V. M.;

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Rastorguev, V. A.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1116-24(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1445-7(Jul 1970).

A systematic theoretical investigation of three-electrode electrostatic telescope systems is described. The results are presented in the form of curves characterizing the paraxial properties of the system and the aberrations. The coefficients of four types of third-order geometric aberrations, analogous to spherical aberration, coma, astigmatism, and distortion of a system with rotation symmetry are calculated. The coefficients of the second-order aberrations (two types of chromatic and two types of geometric aberrations) are also calculated. Curves are given only for accelerating systems with the aperture diaphragm in a definite position. Expressions that make it possible to find the aberration coefficients from the data cited for any diaphragm position in both accelerating and decelerating systems are derived. (auth)

22935 CHROMATIC ABERRATION IN A DEFLECTION SYSTEM FOR A PRISM MASS SPECTROMETER WITH ENERGY FOCUSING. Kel'man, V. M.; Rodnikova, I. V.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1113-15(Jan 1971).

Translated from Zh. Tekh. Fiz.; 40: 1441-4(Jul 1970).

The second-order chromatic aberration of a deflecting system consisting of electrostatic and magnetic prisms that satisfies the first-order achromaticity conditions is calculated. The limitation imposed by this type of aberration on the resolving power of energy-focused prism mass spectrometers is also determined. (auth)

22936 ABOUT HIGHER EFFICIENCY OF LINEAR INDUCTION ACCELERATORS. Grishin, V. K.; Sukharevskii, V. G. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: 591-3(Sep-Oct 1970). (In Russian).

Modifications are suggested for linear induction accelerators by using new magnetic materials and improved feeder arrangements. It is shown that the simplicity of the design, higher beam intensity, more flexible temperature demands (±10°), and uncomplicated possibility of rearrangements of the device for acceleration of various types of particles make linear induction accelerators suitable for efficient experimental studies and technological uses. (R.V.J.)

22937 BEAM FOCUSING IN LINEAR INDUCTION ACCELERATORS. Grishin, V. K.; Sukharevskii, V. G. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: 570-4(Sep-Oct 1970). (In Russian).

A simplified focusing system is suggested for linear induction accelerators which by modifying the annular feeding current into the inductor could reduce the channel cross section which in turn would result in an increased acceleration energy or in a smaller dimensioned installation. Certain alterations are suggested for alternating the ring current within a ring or from one inductor to another resulting in a variable transverse field acting similarly to the system of quadrupole lenses. (R.V.J.)

22938 DEFLECTION AND FOCUSING OF HOMOCENTRIC ION BEAMS BY A MAGNETIC PRISM. Davydovskii, V. Ya.; Kel'man, V. M.; Uteev, M. L.; Yakushev, E. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1235-9(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1588-93(Aug 1970).

The effect of a two-dimensional magnetic prism on homocentric ion beams is studied. Expressions for determining the position of the image and the dispersion of the system are obtained; the geometric second-order aberrations with respect to the angle of divergence of the beam are calculated. The astigmatism of the system can be corrected by a small change in the angle of incidence, giving the system telescope properties. The magnetic prism together with an electrostatic lens can be used to construct mass-spectrometer devices with large dispersion. (auth)

22939 MOVABLE SHIELDS FOR SHAPING AZIMUTHAL FRINGING FIELDS IN A CYCLIC MAGNETIC SYSTEM WITH SLOTS. Kozin, V. P.; Tolstoi, A. E. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1240-4(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1594-9(Aug 1970).

A movable magnetic shield placed at the entrance and exit of each quadrant is used to shape the azimuthal fringing fields in a cyclic system with slots. This makes it possible to produce a sharply falling field with a distribution that is approximately rectangular; it is then possible to make a preliminary calculation of the distribution function for this field, and to obtain an exact correction for the effects of neighboring magnetic elements on the final adjustment of the cyclic system. (auth)

22940 SUPERCONDUCTOR CAVITIES FOR PARTICLE BUNCHING. Grigor'ev, V. P.; Didenko, A. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1270-4(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1632-7(Aug 1970).

A study for beam loading of superconducting accelerating systems is described. The radiation that is produced by the motion of small charged-particle bunches along the axis of a superconductor cavity is considered. The results can be applied to different accelerating systems. (W.H.K.)

22941 ELECTRON TRAPPING IN A BETATRON. Limar, A. G.; Matsiborko, N. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: 1362-3(Feb 1971).

Translated from Zh. Tekh. Fiz.; 40: 1752-3(Aug 1970).

Electron trapping in a betatron has been compared experimentally for two different injections; one is located in the median plane of the accelerator, and the other is above the equilibrium radius. It is shown that the trapping efficiency and the structure of the accelerated beam do not depend on the position of the injector. This result favors a mechanism which is related to the transverse interaction of the electrons in the beam. (auth)

22942 DESIGN OF CANAL ION SOURCES, TAKING ACCOUNT OF APERTURE LENS EFFECTS. Carter, R. G. (English Electric Valve Co. Ltd., Chelmsford, Eng.). J. Phys., D (London); 4: 329-31(Feb 1971).

The design of canal ion sources is discussed taking into account the lens effect of the canal aperture, and the results summarized in a universal design curve. Experimental data available falls between this curve and one in which lens effects are neglected. The relationship between theory and experiment is considered. (auth) (UK)

22943 ELECTRON OPTICS. Klemperes, O.; Barnett, M. E. Cambridge Monographs on Physics. Cambridge, Eng.; Cambridge University Press ([1970]). 519p. £9.

The subject is considered under the following headings; historical introduction, the fundamental principles of electron optics, the cardinal points of an electron lens, field plotting and ray tracing (analogue and computational methods), some electrostatic electron lenses, magnetic electron lenses, lens errors (geometrical aberrations), electronic aberrations, electron optics and space-charge, emission systems and electron guns, deflecting fields. Bibliography. (UK)

22944 EXPERIMENTAL STUDY OF THE LINEAR POLARIZATION OF SYNCHROTRON RADIATION OF HIGH-ENERGY ELECTRONS. Vorob'ev, A. A.; Nikitin, M. M.; Kozhevnikov, A. V. At. Energ. (USSR); 29: 389-91(Nov 1970). (In Russian).

Previous studies of synchrotron radiation at the 1.5-GeV machine of the Tomsk Polytechnic Institute were continued. The optical system used allowed the passage of the whole vertical aperture of the radiation cone. The light radiation of electrons was recorded at a rate of 2000 frames/sec. The angular distribution of the intensity of components of polarization in the vertical plane was determined for various energies of accelerated electrons. The angular distribution of the σ component exhibited a certain amount of asymmetry; the maximum of the distribution of the σ component was found to shift toward the smaller maximum of the π component. Adjustment of the magnetic field allowed to compensate the maxima of the π component of polarization, whereby the asymmetry of the σ component disappeared. The distribution of the intensities of the σ and π components agreed well with theoretical calculations up to energies of 1 GeV. (TTT)

22945 ATTENUATION OF A HIGH-ENERGY NEUTRON FLUX IN A CYLINDRICAL DUCT. Bushuev, N. I.; Kargin, A. N.; Mal'kov, V. V.; Sychev, B. S. At. Energ. (USSR); 29: 378-9(Nov 1970). (In Russian).

The attenuation of the neutron flux generated by 660-MeV protons in the collimator of the shield of the JINR synchrocyclotron was measured in the empty and iron-filled duct under two operational modes of the accelerator and at various polarities of the magnetic field. The neutrons were recorded by means of a threshold type activation detector based on the $^{12}C(n,2n)^{11}C$ reaction; this made it possible to separate out the very fast >20 MeV neutrons. It was found that in the empty duct the attenuation of the neutron flux depends greatly on the operational mode of the accelerator. The attenuation of very fast neutrons was found to be similar to results obtained at CERN at 600 MeV in the 14-cm diameter circular duct in a baryte concrete wall of the synchrocyclotron. The formula was derived by making simplifying assumptions for calculating the attenuation; it yielded values close to the experimental data. (TTT)

22946 MONOCHROMATIZATION OF COLLIMATED COHERENT BREMSSTRAHLUNG FROM A THIN SILICON CRYSTAL. Nishikawa, Tetsuji (Tokyo Univ.); Suzuki, Shiro; Tsuru, Tsuneaki; (and others). J. Phys. Soc. Jap.; 30: 806-10(Mar 1971).

Collimation effects on the coherent bremsstrahlung produced in a thin silicon crystal have been studied by using 1 GeV electrons whose angular divergence is suppressed by scrapers in the synchrotron orbit. The energy spectra of the bremsstrahlung exhibited narrow spikes and large enhancement ratios. The full width at half-maximum of the enhanced spike of 15% has been obtained at the photon energy of 435 MeV. The observed spectra were fitted to the theoretical ones calculated by the least square method. The fit gives the effective collimation angle Θ_{eff} of 0.54 reduced angles. The continuous part was 1.85 times as large as the theoretical prediction. Considering that the mechanical collimation angle Θ_c is 0.32 reduced angles, Θ_{eff} is mainly ascribed to the calculated multiple scattering angle Θ_{ms} of 0.65 reduced angles as well as Θ_c. (auth)

22947 BREMSSTRAHLUNG PRODUCTION AND SHIELDING OF STATIC AND LINEAR ELECTRON ACCELERATORS BELOW 50 MeV. TOXIC GAS PRODUCTION, REQUIRED EXHAUST RATES, AND RADIATION PROTECTION INSTRUMENTATION. Brynjolfsson, Ari; Martin III, Thomas G. (Army Natick Labs., Mass.). Int. J. Appl. Radiat. Isotop.; 22: 29-40(Jan 1971).

Shielding requirements, exhaust rates, stack heights, interlocks, and health physics instrumentation which must be considered in designing and operating electron accelerator facilities below 50 MeV are reviewed. Angular distribution over 4π solid angle, spectral distribution, and intensity of the x-rays are calculated and measured as a function of electron energy, beam current, target material and thickness. The results are used to calculate the concrete shielding requirements as a function of electron energy and beam current. Based on experimental determinations, the production rates of ozone and radioactive nitrogen and oxygen are calculated as a function of energy, beam current, and dimensions of the radiation cell. The results are then used to calculate the required exhaust rate for safe entrance to the cell after shutdown and the necessary stack heights for the exhaust gas. Finally, interlock systems and the limitations of radiation survey instruments are discussed. (auth) (UK)

22948 INEXPENSIVE ENERGY FILTER LENS FOR LARGE DIAMETER ELECTRON BEAMS. Zeman, H. D.; Jost, K.; Gilad, S. (Stanford Univ., Calif.). Rev. Sci. Instrum.; 42: 485-9(Apr 1971).

The theory behind the use of a rotationally symmetric hyperbolic electrostatic field as an energy filter lens for electrons is discussed. The design of such a lens for use in eliminating inelastically scattered electrons from the output beam in a low energy electron scattering experiment is described. A filter lens designed, built, and tested by the authors is described. It has an entrance aperture of 1.27 cm diameter, an angular acceptance of $\pm 2°$, and a measured energy cutoff width of $(0.27 \pm 0.02)\%$. (auth)

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PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 21475, 22632, 22640, 22973, 23254, 23390, and 23391.

22949 (JPRS-52290, pp 25-45) METHOD OF CALCULATING GROUP CROSS SECTIONS IN THE AREA OF UNRESOLVED RESONANCES. Nikolaev, M. N.; Abagyan, L. P.; (and others). Translated from Studies in Physics and Power Engineering.

A method for calculating group-average cross sections considering resonance self-shielding in the area of unresolved resonances is presented. The parameters of a quasirandom sequence of resonances were produced for this purpose, considering fluctuations in neutron widths and separations between levels. (auth)

22950 (RT/FI-(70)27) SOLUTIONS FOR THE INTEGRAL NEUTRON TRANSPORT EQUATION BY DIRECT DECOMPOSITION OF ITS KERNEL. Premuda, F. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). 1970. 43p. Dep. NTIS (U. S. Sales Only).

A new method is presented for solving the integral Boltzmann equation for monoenergetic neutrons. The kernel of such an equation is expanded into a series of polynomials of one of its variables in each region of the physical system, one- or multi-layer, considered. The spatial distribution in both critical and subcritical conditions and the criticality equation are obtained without resorting to the eigenfunction expansion method or to the integral transformation technique. The angular flux is also evaluated, through the integral equation, which relates it to the total flux on the hypothesis of isotropic scattering and fission. (auth)

22951 (TID-25644) MULTI-GROUP NEUTRON TRANSPORT THEORY IN PLANE GEOMETRY. McCrosson, F. Joseph (Virginia Polytechnic Inst., Blacksburg). Aug 1968. 137p. Dep. NTIS.

Thesis.

An exact analytical procedure is presented for solving multigroup neutron transport problems in plane geometry. The method consists of analyzing a system of singular integral equations which is derived for the neutron distribution. Included in these singular integral equations are arbitrary inhomogeneous terms which depend only on the angle variable. Once these arbitrary functions are determined, the neutron distribution can be obtained from the singular integral equations by standard methods. To illustrate the procedure the inhomogeneous terms associated with the infinite medium Green's function are determined. The Milne and critical problems are also considered. Here the inhomogeneous terms are expressed in terms of the emerging distribution at the boundary and the emerging distribution is given by a system of coupled Fredholm integral equations. The relationship between this method and Case's eigenfunction method is investigated. This leads to an alternate procedure for determining the expansion coefficients in Case's method. 18 references. (auth)

22952 STUDIES OF ASYMPTOTIC P_n AND DOUBLE P_n APPROXIMATIONS TO THE MONOENERGETIC NEUTRON TRANSPORT EQUATION. Huang, Song Teh. Evanston, Ill.; Northwestern Univ. (1970). 149p. University Microfilms Order No. 71-1873.

Thesis.

Using the concept of a pseudo-scattering kernel, the asymptotic P_n and DP_n theories are formulated in the homogeneous infinite medium with isotropic scattering. By imposing exact spatial characteristics of the asymptotic flux on the AP_n (or ADP_n) parameters, these asymptotic theories give the best asymptotic approximation and yield better results than the corresponding P_n or DP_n theories when the transient is small. The convergence criteria of the AP_n and ADP_n theories are examined from a number of aspects and are compared with those of the corresponding P_n and DP_n theories. The source free Milne problem and the Milne problem with a spatially constant source are used to study the effects of a boundary on the asymptotic theories. Various vacuum boundary conditions such as Mark, Marshak and Pomraning conditions are compared. The results of the emerging current in the half-space Green's function problem show that the asymptotic theories yield much better results than the corresponding P_n and DP_n theories when the source is far away from the boundary. (Diss. Abstr. Int., B)

22953 APPARENT SPECULAR REFLECTION OF NEUTRONS BY A ROUGHENED SURFACE. Bates, J. C. (Universities Research Reactor, Risley, Eng.). Nucl. Instrum. Methods; 91: 297-8(1971).

The apparent specular reflection of neutrons by a ground-glass surface was observed; it is explained in terms of multiple refraction. (auth)

22954 THEORY OF THE QUASIELASTIC NEUTRON SCATTERING BY HYDROGEN IN BCC METALS APPLYING A RANDOM FLIGHT METHOD. Gissler, W.; Rother, H. (EURATOM, Petten, Netherlands). Physica; 50: 380-90(7 Dec 1970).

A method for the calculation of the neutron scattering function for hydrogen diffusing by jumps through interstitial-site lattices is developed. The method can be generalized to all systems where jump diffusion occurs. The method is well adapted to digital evaluation and can conveniently be applied to nonprimitive interstitial-site lattices. Explicit results are given for tetrahedral, octahedral, and cubic interstitial-site lattices in bcc host lattices. The experimentally determined half-width of the NbH_x system is fitted to the theoretical results. Above the critical temperature, the results are only compatible with the assumption of multistep jumps. (auth)

22955 DOUBLE THERMAL-NEUTRON POLARIZER. Obinyakov, B. A.; Mostovoi, Yu. A. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 3, 729-32(May-Jun 1970).

Translated from Prib. Tekh. Eksp.; No. 3, 87-90(May-Jun 1970).

A thermal-neutron polarizer made up of two sets of opposing cobalt mirrors is described, and its optimum parameters are calculated. The reflecting surface of each set has an area of 120×12 cm. The flux of polarized neutrons in a 12-cm-high beam is $4 \cdot 10^7$ neutrons/sec, and the degree of polarization is $\approx 85\%$. (auth)

22956 EXPERIMENTS WITH ULTRACOLD NEUTRONS. Groshev, L. V. (Inst. of Atomic Energy, Moscow); Dvoretskii, V. N.; Demidov, A. M.; (and others). Phys. Lett.; 34B: 293-5 (1 Mar 1971).

Energy spectra, diffusion parameters, and storage times of ultracold neutrons are measured. (auth)

22957 THEORY OF PULSED NEUTRON SOURCES IN HETEROGENEOUS MEDIA. Stepanov, A. V. At. Energ. (USSR); 29: 371-2(Nov 1970). (In Russian).

A previously derived formula to express changes of λ (the attenuation constant in time of the fundamental spatial harmonic of the neutron distribution in a heterogenous medium) was examined. The formula represents a generalization of an expression of λ in the case of thermalization in a homogeneous medium. The large number of parameters in the formula makes it difficult to compute the values. A new expression was derived on the basis of the neutron transport theory, assuming that the experimentally obtained value of λ is comparable with the attenuation constant of the microscopic neutron flux. The linear extrapolation length d_i in the P_1 approximation was determined by an expression which contained a numerical coefficient of $\frac{2}{3}$; in the generalized version 0.71 for $\frac{2}{3}$. In "poisoning" experiments involving nonhomogeneous systems, a multivelocity correction, which depends under concentration of the absorber N, is introduced in the system. It is shown that an analysis of the $\lambda = \lambda(N)$ relation allows to estimate the block effect of the absorption on the thermalization of neutrons. (TTT)

22958 DEGENERATE-KERNEL CALCULATIONS OF TIME EIGENVALUES IN NEUTRON THERMALIZATION. Normand, Eugene. Seattle; Univ. of Washington (1970). 215p. University Microfilms Order No. 71-1009.

Thesis.

A new degenerate kernel formalism was developed to facilitate the calculation of time eigenvalues in thermal neutron systems. Infinite-medium time eigenvalues were obtained by constructing degenerate kernels for both the simple diffusing atom and free diffusion models for liquid moderators, as well as for the free gas model. Use of the degenerate kernel has reduced the time eigenvalue problem from the solution of the integral form of the neutron balance equation to the solution of a set of linear algebraic equations. This kernel had further merit in that error bounds for the calculated eigenvalues could be obtained analytically by using a functional inequality. The degenerate kernels were constructed by expanding symmetric and square integrable kernel operators, defined in terms of the exact scattering kernels and scattering cross sections, via the bilinear formula. In determining the auxiliary eigenfunctions, $t_n(x)$, and auxiliary eigen-

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values, c_n, of the compact kernel operators, low-speed, one-term approximations of the scattering kernels and scattering rates were made. These approximations permitted retention of the essential physics of the problem and permitted analytical determination of the lowest order sets of $t_n(x)$ and c_n for the free gas and simple diffusing atom models. With the corresponding lowest order degenerate kernels, the time eigenvalues were calculated and supplemented with analytically-determined error bounds. The accuracy of the time eigenvalues was improved by generating more exact auxiliary eigenfunctions and eigenvalues by a series expansion in terms of the lowest order set. The validity of this procedure was verified by comparing the calculated hydrogen gas time eigenvalue with published results. The degenerate kernel method was applied to two liquid moderators, water and liquid sodium, for both the simple diffusing atom and free diffusion (continued-fraction) models. For both models, the time eigenvalues for water compared favorably with published values, although the latter were based on the effective width model. The liquid sodium simple diffusing atom model time eigenvalues were found to be inferior to those for the free diffusion model in which the atomic mass is accounted for more directly. Information about time eigenvalues in finite media was obtained by calculation of the diffusion-theory value of the buckling for which discrete time decay ceased to exist. Two different approaches were taken in utilizing the finite medium degenerate kernel, based on the lowest-order $t_n(x)$ and c_n. The first approach reduced the problem to that of a secular determinant, while the second made use of an equation which was derived from the error bounding technique. For the free gas, both methods gave similar values for hydrogen gas. Convergence problems, however, were encountered with the simple diffusing atom model for liquids. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, A≤ 5

22959 (ITF–70–67–E) SATURATION FOR THE INTERACTION WITH HARD CORE. Maksimenko, V. N.; Steshenko, A. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 10p. Dep. NTIS (U. S. Sales Only).

The possibility of providing for stability with respect to contraction for some two-body exchange central potentials with hard cores is investigated in the light doubly-magic nuclei ^{4}He, ^{16}O, and ^{40}Cd. The calculation is carried out by the variational method on oscillator functions. The hard core is considered in the gas approximation. The results turn out to be negative. (auth)

22960 (LA–4543) ENERGY LOSS BY NUCLEAR ELASTIC SCATTERING. Devaney, Joseph J.; Stein, Myron L. (Los Alamos Scientific Lab., N. Mex.). Oct 1970. Contract W-7405-eng-36. 12p. Dep. NTIS.

The rate of energy loss suffered by a heavy charged particle from nuclear forces elastic scattering, plus nuclear Coulomb interference, is derived, and the rate for protons, deuterons, and alphas into deuterium is given as a function of incident energy. (auth)

22961 (NBS-SPEC. PUBL–322) PHOTONUCLEAR DATA INDEX, JANUARY 1965–JANUARY 1970. (National Bureau of Standards, Washington, D. C.). May 1970. 84p. GPO $0.75.

A data index of quantitative information in the field of photonuclear reactions is presented. The measurements given have information on the electromagnetic matrix element between the ground and excited states of the studied nucleus. The energy range is from 0 to 150 MeV, and mostly in the region of the giant dipole resonance. (J.F.P.)

22962 (NP–18497) PROGRESS REPORT, 1969–1970. (Stichting Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). 96p. Dep. NTIS (U. S. Sales Only).

ALKALI METAL HALIDES — reactions with recoil tritium, products from
BERYLLIUM-9 — alpha reactions (α,2α) at 56 MeV, momentum transfer dependence in (E)
— proton reactions at 50 MeV, energy correlation spectra from (E)
CARBON-12 — deuteron elastic scattering at 26 MeV, angular distribution for (E)
CARBON — electron elastic scattering at 20 to 80 MeV, form factor for (E)
CARBON TETRACHLORIDE — reactions with recoil chlorine-34, effects of aliphatic aromatic compounds on production of labeled products by
CERIUM-138 — energy-level scheme from barium-138 (α,4n) reactions (E)
CHLORINE-34 — reactions of recoil, in carbon tetrachloride, effects of aliphatic aromatic compounds on production of labeled products by
COPPER-63 — electron inelastic scattering at 80 MeV, electron spectra from (E)
DEUTERIUM — deuteron reactions (d,2p) and (d,pd) at 26 MeV, energy correlation spectra from (E)
HYDROAROMATIC COMPOUNDS — production of labeled, in chlorine-34 recoil reactions with carbon tetrachloride
HYDROGEN — helium-3 reactions (He-3,d) at 70 MeV, deuteron-diproton coincidence spectra from (E)
— deuteron reactions (d,2p) at 26 MeV, n-p correlation energy spectra from (E)
LEAD ISOTOPES — electron elastic scattering at 50 to 80 MeV, cross-section differences in (E)
LINEAR ACCELERATORS — experimental facilities at 85-MeV electron EVA
LITHIUM-7 — electron elastic and inelastic scattering at 35 to 90 MeV, electron spectra from (E)
NEODYMIUM-140 — energy-level scheme from cerium-140 (α,4n) reactions (E)
SCANDIUM-43 — electron elastic scattering at 50 to 65 MeV, spectra from (E)
SYNCHROCYCLOTRONS — operation of IKO
THULIUM-164 — beta and electron-capture decay scheme of ground-state and isomeric (E)
TITANIUM — electron elastic scattering at 50 to 65 MeV, spectra from (E)
TRITIUM — reactions of recoil, in solid alkali metal halides, products from
TUNGSTEN-172 — decay of, γ energies and intensities and half-life for (E)
VANADIUM-51 — electron elastic scattering at 50 to 65 MeV, spectra from (E)

22963 SECOND-ORDER CONTRIBUTION TO THE BINDING ENERGY OF DOUBLY-CLOSED-SHELL NUCLEI. Kreuzer, H. J. (Univ. of Alberta, Edmonton); Schuette, D. Nuovo Cim.; 70A: 199-212(21 Nov 1970).

A new method of calculating the second-order contribution to the binding energy of closed-oscillator-shell nuclei from an effective two-body interaction is presented. The one-particle states are represented by oscillator functions. The one-particle energies entering the energy denominator are averaged but taken different in each oscillator shell. The Pauli projector is treated exactly. This oscillator approximation is carried out in ^{4}He and ^{16}O for an effective interaction of Hamada–Johnston type. A careful comparison and discussion of the plane-wave and closure approximations are also given. (auth)

22964 LOW-ENERGY ELECTRON SCATTERING AND DISPERSIVE EFFECTS. Bottino, A.; Ciocchetti, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Phys. Lett.; 34B: 187-90(15 Feb 1971).

The role and importance of dispersive effects in electron scattering from light nuclei are analyzed in connection with the determination of $\langle r^2 \rangle$ by low-energy experiments. (auth)

22965 ^{3}H AND ^{3}He FORM FACTORS WITH THE HJ POTENTIAL. Hennell, M. A.; Delves, L. M. (Univ. of Liverpool). Phys. Lett.; 34B: 195-6(15 Feb 1971).

The charge and magnetic form factors F_{ch}, F_{mag} of ^{3}H and ^{3}He are computed for the HJ potential; mesonic corrections are neglected. The results show a well-defined diffraction minimum at $q^2 = 12.6$ fm^{-2}, and agree quite well with experiment. Inclusion of a three-body potential to fit the energy to −8.4 MeV, however, moves the minimum out to 14 fm^{-2}, in worse agreement with experiment. (auth)

22966 SQUARE-WELL POTENTIAL AND THREE-NUCLEON BOUND-STATE PROPERTIES. Van Wageningen, R.; Erens, G. (Vrije Univ., Amsterdam). Phys. Lett.; 34B: 184-6(15 Feb 1971).

The fact that several three-nucleon bound-state properties calculated with square-well potentials are very close to the corresponding values for repulsive-core potentials is attributed to the comparatively strong attraction at large distances. (auth)

22967 DIFFERENTIAL CROSS-SECTION FOR ^{3}He–^{4}He ELASTIC SCATTERING AT 44.5 MeV CENTER-OF-MASS ENERGY. Fetscher, W. (Univ., Karlsruhe, Ger. Kernforschungs-

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zentrum, Karlsruhe, Ger.); Sattler, K.; Schmeing, N. C.; (and others). Phys. Lett.; 34B: 171-3(15 Feb 1971).

The differential cross section for 104-MeV ^{4}He elastic scattering by ^{3}He was measured. Phase-shift analysis was performed, and the experimental values are compared with the results of optical-model and cluster-model calculations. (auth)

22968 LEVINSON'S THEOREM AND S-WAVE NEUTRON–DEUTERON SCATTERING. Sloan, I. H. (Univ. of New South Wales, Kensington). Phys. Lett.; 34B: 243-4(1 Mar 1971).

S-wave phase shifts are calculated for a separable-potential neutron–deuteron model up to E_n = 100 MeV and are found to satisfy the modified Levinson's theorem proposed by Swan. The effect of the Pauli principle on Levinson's theorem is illustrated with a simple three-body model. (auth)

22969 LOW-MOMENTUM K^-–^{4}He INTERACTIONS. Mazur, Peter Ogden. Evanston, Ill.; Northwestern Univ. (1970). 81p. University Microfilms Order No. 71-1912.

Thesis.

An analysis of low-momentum K^- – ^{4}He interactions observed in the Northwestern University 50 cm helium bubble chamber is presented. The differential elastic scattering cross sections were measured in the momentum intervals 100 to 150 and 150 to 200 MeV/c, and the total inelastic cross section in the interval 150 to 200 MeV/c was measured. The topological interaction types for in-flight inelastic events and at-rest absorption events were compared. A phase shift analysis of elastic K^- – ^{4}He scattering in the momentum interval 150 to 200 MeV/c requires complex s-, p-, and d-wave phase shifts for a satisfactory fit, whereas the d-wave contribution is negligible in the momentum interval 100 to 150 MeV/c. The phase shift analysis could not resolve the ambiguity of the absolute signs of the real parts of the phase shifts. A zero effective range scattering length analysis successfully resolved this ambiguity. However, there were two solutions found, basically differing only in the sign of the real portion of the d-wave scattering length. Arguments using the impulse model qualitatively explain the presence of p and d waves in the K^- – ^{4}He scattering, although only s waves are needed to analyze K^- – nucleon data in the same momentum region. The impulse picture favors the scattering length solution in which the real parts of the s-, p-, and d-wave phase shifts are all positive. Using the scattering lengths, the absorption rates from the 3d and 2p states of the K^- – ^{4}He mesic atom, as well as the 1s and 2p energy level shifts were calculated. It is concluded that the 1s energy level will be more tightly bound by 0.94 ± 5.67. Further, ~3% of those kaons arriving at the 3d level are absorbed whereas ~99% of those arriving at the 2p state are absorbed. The total inelastic cross section in the interval 150 to 200 MeV/c was measured to be 250 ± 44 mb. Analysis showed that a major fraction of the inelastic cross section is due to p-state absorption. The branching ratios were analyzed into various hyperonic channels for the in-flight inelastic events, and these were compared with the corresponding channels for at-rest absorption. These branching ratios are the same within statistics. In particular, it is found that the fraction of two-nucleon absorption events is given by 0.32 ± 0.02 for the at-rest events and 0.27 ± 0.13 for the in-flight events. The similarity between the (predominantly) p-wave absorption reactions in flight and the corresponding at rest data, taken together with the large mesic 2p absorption rate, strongly suggests that K^- mesons at rest are captured mainly from p states. (Diss. Abstr. Int., B)

22970 ELECTROMAGNETIC BREAKUP OF A = 3 NUCLEI. Lehman, Donald Richard. Washington, D. C.; George Washington Univ. (1970). 136p. University Microfilms Order No. 70-27,081.

Thesis.

Electromagnetic breakup of A = 3 nuclei is studied by investigation of low-energy photodisintegration of ^{3}He and quasi-elastic electron scattering from ^{3}H and ^{3}He. The overall objective is to determine what information about the two-nucleon interaction is necessary to describe presently available data. Specifically, the suppression of the isospin-½ three-body photobreakup of ^{3}He, plus the electrodisintegration data for ^{3}H and ^{3}He, are investigated. Model calculations are performed with zero-range and effective-range wave functions, as well as with wave functions derived from separable two-nucleon potentials. The almost complete absence of isospin-½ three-body breakup in low-energy photodisintegration of ^{3}He is seen to be due equally to the symmetries of the $S = \frac{1}{2}$, $I = \frac{1}{2}$ states and the influence of the two-nucleon bound state on the three-body final-state interaction. Good agreement is obtained with all the electrodisintegration data, except the ^{3}He coincidence data, for wave functions derived from separable potentials fitted to the s-wave two-nucleon phase shifts to 340 MeV It is shown that the singlet rescattering corrections between the spectator particles are essential to obtain agreement with electrodisintegration data. These results suggest the need for more refined and reliable coincidence data. Throughout this work it is apparent that an effective-range fit to the two-nucleon data is not adequate to describe the electromagnetic breakup of ^{3}He and ^{3}H, but a fit to the two-nucleon s-wave phase shifts up to several hundred MeV is necessary. However, no further information about the two-nucleon interaction is required to describe presently available electromagnetic breakup data. (Diss. Abstr. Int., B)

22971 ELASTIC SCATTERING OF MEDIUM-ENERGY NEUTRONS FROM HYDROGEN AND DEUTERIUM. Romero, Juan Luis. Davis, Calif.; Univ. of California (1970). 116p. University Microfilms Order No. 70-26,498.

Thesis.

The n–d and n–p differential cross sections for elastic scattering at 36.0 and 46.3 MeV were measured. The angular range covered was 15 to 170°C.M. The forward angles were measured by using a liquid scintillator target consisting of deuterated or ordinary heptane and detecting the neutron in a previously calibrated neutron detector in coincidence with the recoil particle in the liquid scintillator. The backward angles were measured using thin targets of deuterated or ordinary polyethylene and detecting the recoiling charged particle with E–ΔE solid state detectors. A monochromatic neutron beam from the (p,n) reaction of ^{7}Li was selected by timing with a beam pick-off. The absolute differential cross section was obtained by integrating the n–p angular distribution to the total n–p cross section. The n–d differential cross section agrees well in shape and absolute value with p–d. A slightly more pronounced minimum seems to be present in the n–d results. From measured values of the total n–d cross section, one obtains for the total n–d elastic cross sections the values of 154 ± 9 mb and 94 ± 6 and at 16.0 and 43.3 MeV respectively, the n–p differential cross sections are compared with MacGregor's unconstrained phase shift solution. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 22683, 22959, 22961–22964, and 23087.

22972 (COO-1573-71) NUCLEAR PHYSICS LABORATORY PROGRESS REPORT, NOVEMBER 1, 1969–OCTOBER 31, 1970. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Contract AT(11-1)-1573. 57p. Dep. NTIS.

HELIUM-4—trineutron elastic scattering by, angular distribution for, (T)
LITHIUM-7—neutron reactions at 19 MeV, trineutron production cross section for, (E)
NEON-20—helium-3 reactions (He-3,n) at 3 to 8 MeV, neutron spectra from, (E)
OXYGEN-16—deuteron reactions (d,n) at 3 to 4 MeV, neutron polarization from, (E)
RADIATION DETECTORS, SCINTILLATION—resolution and linearity of helium gas, for neutrons
—efficiency of NE-102 and NE-213, for neutrons
TRINEUTRONS—search for bound, (E) (J.W.R.)

22973 (JUL-668-RG) COLLI: PROGRAM PACKAGE FOR CALCULATION OF THERMAL-NEUTRON SCATTERING. Schroeder, Guenter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jul 1970. 139p. (In German). Dep. NTIS (U. S. Sales Only).

The program package COLLI calculates the scattering law $S(\alpha,\beta;T)$ for moderators of random structure and composition (for example, crystals consisting of one or more atomic species, molecules, liquids, etc.); for these moderators the frequency distribution of the atomic oscillations (phonon spectrum) and the bound cross sections (sigma bound, scattering lengths) of the individual atoms are already known for a given temperature in incoherent approximation. The scattering law can be stored in the ENDF/B format for several moderator temperatures on magnetic tapes (program LIBRA), so that in the calculation of the scattering matrix a temperature interpolation is possible. The energy-dependent differential scattering cross section (scattering matrix) is calculated (program SIGMA) by numerical integration of the scattering law for a random moderator temperature (temperature interpolation) as well as either point cross section $\sigma(E_s \rightarrow E; T)$ or mean group cross section $\bar{\sigma}_{s\rightarrow s'}$ for a random energy division and stored for further processing on magnetic tapes. With the

help of the program HEXSCAT, the elastic coherent fraction of the scattering cross section $\overline{\sigma_{g,el}}$ (group averaged) is obtained from the lattice parameters, the Debye–Waller factor, and the knowledge of the form factors built into the program for graphite, beryllium, and beryllium oxide. From the elastic fraction the total scattering cross section $\overline{\sigma_{g,t}}$ is calculated, and the elastic interaction can be considered as the diagonal element of the scattering matrix $\overline{\sigma_{g\to g'}}$. The physical theory necessary for the calculation of the scattering law and scattering matrix is first explained so that an understanding of the methods and approximations used is possible. An accurate description of the methods and procedures (program organization and control, interpolation and integration procedures) used in the programing and the program presentation for the program parts COLLI, LIBRA, SIGMA, and HEXSCAT is given. The calculation of the scattering matrix of beryllium oxide from the phonon spectrum of Sinclair for 293°K is given with complete input and output as a typical example. The listings of the main program COLLI and the program SIGMA are included. The calculated scattering matrix of beryllium oxide $\overline{\sigma_{g\to g'}}$ is given for 293°K in the 96-energy-group distribution of the THERMOS program. (J.S.R.)

22974 STUDY OF THE $^{14}N(p,2p)^{13}C$ QUASI-ELASTIC, $^{14}N(p,pd)^{12}C$ QUASI-ELASTIC, AND $^{14}N(p,pd)^{12}C$ SEQUENTIAL DECAY REACTIONS AT 46 MeV. Welch, Lester Clint. Los Angeles; Univ. of Southern California (1970). 100p. University Microfilms Order No. 71-2541.

Thesis.

Three correlation experiments resulting from p + ^{14}N were studied with an incident proton beam of 46 MeV. The kinematically complete reactions studied were the $^{14}N(p,2p)^{13}C$ quasi-elastic, $^{14}N(p,pd)^{12}C$ quasi-elastic, and the $^{14}(p,pd)^{12}C$ sequential decay reactions. The quasi-elastic $^{14}N(p,2p)^{13}C$ reaction was studied using a symmetric coplanar geometry from 20° to 75° in 5° steps in the laboratory. This reaction is interesting because of the accumulation of data on other 1p nuclei and hence the dependence of the reaction on nuclear characteristics can be investigated. The data were analyzed using a distorted wave t-matrix theory which involved an analytical expression for the wave functions which reproduced the major distortion effects. By doing a parameter study, a fit was obtained for the data which is significantly better than other fits to (p,2p) data. The quasi-elastic $^{14}N(p,pd)^{12}C$ reaction leading to the ground state and the (2^+) 4.4 MeV level of ^{12}C was studied. These data were obtained by explicitly invoking the restriction $||p_p| - |p_d|| \leq 25$(MeV/c). These are the first such data obtained involving such a restriction, hence better approximating the quasi-elastic condition. The angular correlation showed a predominant $^3D_1$ configuration with a mixture of $^3S_1$. The reaction leading to the 4.4 MeV level was favored, in the forward angles, over the reaction leading to the ground state. Data were obtained from 20° to 75° in 5° steps. The sequential decay reaction $^{14}N(p,pd)^{12}C$ in which a deuteron is produced via a direct interaction and the resulting nucleus, ^{12}N, decays, by proton emission, was studied for θ_d = 30° and θ_p varied from 65° to 135° by 10° steps. Three states in ^{13}N were populated at 7.4 MeV, 8.9 MeV, and 11.6 MeV. These states then decay to kinematically possible states in ^{12}C. This decay scheme is the most extensive studied thus far involving particles. (Diss. Abstr. Int., B)

22975 MEDIUM-ENERGY STUDIES OF (p,pα) REACTION ON LIGHT NUCLEI. Quinn, James Reed. Los Angeles; Univ. of California (1970). 133p. University Microfilms Order No. 71-681.

Thesis.

The coplanar energy and angular correlations of the proton and alpha particles emitted from the (p,pα) reaction on ^9Be, ^{16}O, and ^{20}Ne have been measured at 46.8 MeV incident energy. The ^9Be target was also observed at 35.0 and 26.0 MeV incident energy. The targets were of the natural isotopic mixtures. The experiment was performed using two E–ΔE counter telescopes, one to observe the alpha particles and one to observe the correlated protons. Four linear signals for each event were serially listed on magnetic tape using an on-line computer. Off-line computerized data processing is described. Angular distributions about a quasi-elastic angular set were measured for each target at each incident energy. The gas target results show little evidence of a quasi-elastic p–α scattering mechanism. The dominant reaction mechanism for ^{16}O and ^{20}Ne appears to be an inelastic excitation of target nucleus with subsequent alpha decay. The dominant feature of the 46.8 and 35.0 MeV ^9Be data is a broad quasi-elastic enhancement. In the 26.0 MeV data, this feature is not as dominant. A 1S harmonic oscillator wave function is fitted to the angular distributions. A comparison with similar measurements of the cluster model wave function of the target nuclei is made. (Diss. Abstr. Int., B)

22976 POLARIZATION OF NEUTRONS FROM THE $^{13}C(d,n)$ REACTION. Lindstrom, Walter William. Cleveland; Case Western Reserve Univ. (1970). 100p. University Microfilms Order No. 71-1721.

Thesis.

Polarization angular distributions for $^{13}C(d,n)$ neutrons leading to the ground and first five excited states of ^{14}N have been obtained for 1.7, 2.3, and 2.5 MeV incident deuterons. Relative yield excitation functions at 20 and 90 degrees (LAB) have also been measured over this energy range in 50 keV steps. Polarization excitation functions at 20 degrees (LAB) were also obtained for the third, fourth, and fifth ^{14}N excited state groups. The polarization distributions for the ground state group and the first, third, and fifth excited state groups were found to be slowly varying with energy even though considerable compound-nucleus contributions were indicated by yield fluctuations. Polarization predictions may therefore be possible by simple addition of an unpolarized background contribution, varying slowly with energy, to optical model direct reaction calculations. (Diss. Abstr. Int., B)

22977 MEASUREMENT AND COMPOUND-NUCLEUS ANALYSIS OF THE ELASTIC SCATTERING OF ALPHA PARTICLES BY ^9Be. Goss, John Douglas. Columbus, Ohio; Ohio State Univ. (1970). 402p. University Microfilms Order No. 70-26,289.

Thesis.

The elastic scattering of alpha particles by ^9Be has been measured for bombarding energies from 1.7 to 6.2 MeV. Ten excitation curves were measured in 50 keV steps for center of mass angles from 85.8° to 167.2°. Among these angles are the angles for which the Legendre polynomials $P_{l\ odd}$, P_2, P_3, and P_4 are zero. The excitation curves exhibit strong cross-section variations, indicative of compound nucleus formation. The variation is especially noticeable near 5 MeV; angular distributions were measured at the bombarding energies 5.00, 5.05, 5.10, 5.15, and 5.5 MeV. The data has been analyzed with compound nucleus theory, and a computer code has been written to calculate the elastic scattering cross section in the "few-level" approximation. The ten excitation curves and five angular distributions have been fit for bombarding energies from 3.5 to 5.5 MeV. In this energy range, levels in ^{13}C have previously been seen from other reactions at 4.00, 4.18, 4.50, 5.00, and 5.40 MeV, though only the levels at 4.18 and 4.50 MeV have previously been assigned spins and parities. From the analysis of the present data, levels are also observed at 3.80 and 5.075 MeV. Assignments of the spin and parity and the determination of the total width and the alpha-particle partial width has been made for each of the levels. The levels at 3.80, 4.00, 4.18, 4.50, 5.00, 5.075, and 5.50 MeV have been given the assignments of $3/2^-$, $3/2^-$, $1/2^+$, $3/2^+$, $5/2^-$, $1/2^+$, and $5/2^+$, respectively. Comparison of these assignments with the results of the analysis of polarization data of the ground state neutrons from the $^9Be(\alpha,n_0)$ reaction by DeMartini et al., and also comparison with the results of preliminary analysis (done in the present work) of the angular distribution data for $^9Be(\alpha,n_0)^{12}C$ (measured by Weil et al.), indicate strong support for these assignments and widths. (Diss. Abstr. Int., B)

22978 EXPERIMENTAL INVESTIGATION OF THE $^9Be(d,\gamma)$ ^{11}B REACTION. Battleson, Kirk Wayne. Eugene, Oreg.; Univ. of Oregon (1970). 157p. University Microfilms Order No. 71-1294.

Thesis.

The University of Oregon Van de Graaff accelerator facility has been used to investigate the $^9Be(d,\gamma)^{11}B$ reaction with a pulsed deuteron beam. The experimental technique employed permits discrimination by time-of-flight between gamma and neutrons events in a 5″ × 5″ NaI(Tl) detector. This method also reduces bothersome cosmic ray background by a factor of two hundred. Absolute cross sections were measured for the transitions to the ground and first excited states over the energy range from 560 to 3600 keV. Resonances in the reaction due to ^{11}B excited states have been found at deuteron energies of 2.05 ± .06 and 3.10 ± .10 MeV. The excitation energy of the latter state appears to be a measure of the $s_{\frac{1}{2}} - p_{\frac{3}{2}}$ energy difference in the ^{12}C nucleus which had previously been measured much less accurately by the $^{12}C(p,2p)^{11}B$ reaction. Legendre polynomial coefficients were derived by fitting angular distribution measurements at twenty-one energies from 1.0 to 3.4 MeV. The angular distributions for both the transition to the ground state and the first excited state show a forward peaking at most energies with the packing being more pronounced in the latter transition. A dead-time correction theory for electronic losses for the case of a pulsed beam experiment is deduced and presented. (Diss. Abstr. Int., B)

22979 EFFECT OF THE CORE SPIN ON THE EXCHANGE OF NUCLEONS IN THE SCATTERING OF ^{14}N ON ^{12}C AND ^{13}C.

XUM

Von Oertzen, W.; Bohlen, G.; Gebauer, B.; Habib, E. E.; Marquardt, N. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 34B: 51-3(18 Jan 1971).

The elastic scattering of ^{14}N on ^{12}C and ^{13}C has been measured at the same CM energy (9.8 MeV). The oscillatory structures observed in the two angular distributions are out of phase. This fact is well reproduced by an analysis using molecular wave functions which takes into account the spin of the target nuclei. (auth)

22980 LOW-ENERGY CROSS SECTIONS FOR $^{7}Li(p,\alpha)^{4}He$ AND $^{6}Li(p,\alpha)^{3}He$. Spinka, H. (California Inst. of Tech., Pasadena); Tornbrello, T.; Winkler, H. Nucl. Phys.; A164: 1-10 (1971).

Reaction cross sections for $^{6}Li(p,\alpha)^{3}He$ and $^{7}Li(p,\alpha)^{4}He$ were obtained using lithium beams and a CH_4 gas target at equivalent proton energies between 130 and 560 keV. The Rutherford scattering of lithium on carbon was used as a cross-section standard. For $^{6}Li + p$, an extrapolation of the cross section to the energy region of astrophysical interest is given. (auth)

22981 THE (d,^{6}Li) REACTION ON LIGHT NUCLEI. McGrath, R. L. (State Univ. of New York, Stoney Brook); Hendrie, D. L.; McClatchie, E. A.; Harvey, B. G.; Cerny, J. Phys. Lett.; 34B: 289-92(1 Mar 1971).

The (d,^{6}Li) reactions on ^{12}C, ^{16}O, ^{20}Ne, ^{24}Mg and ^{25}Mg have been studied at 55-MeV incident energy. Some features of the data appear consistent with an α-particle pickup model of the reaction. The $^{24}Mg(d,^{7}Li)^{20}Ne$ results complement previously published $^{16}O(^{7}Li,t)^{20}Ne$ work and support the Elliot SU_3 classification scheme for low-energy states of ^{20}Ne. (auth)

22982 ANALYSIS OF INELASTIC SCATTERING OF POLARIZED PROTONS BY ^{11}B. Lowe, J. (Univ. of Birmingham, Eng.). Nucl. Phys.; A162: 438-48(1971).

A coupled-channels analysis is presented of the inelastic scattering of 30.3 MeV polarized protons by ^{11}B. Simple shell-model wave functions are used, and the interaction is expressed as a sum of nucleon–nucleon interactions. The use of an effective interaction derived from the Hamada–Johnston force gives a rather poor fit, particularly to the asymmetry data. The fit is improved by the addition of renormalization terms, but is still not good. An effective nucleon–nucleon interaction is found which gives a qualitative fit to the data. The effect of changes in nuclear wave functions and in the optical potentials is investigated and found to be rather small. (auth)

22983 NUCLEAR ELASTIC SCATTERING OF IDENTICAL OXYGEN ISOTOPES. Shaw, Robert Wilson Jr. Seattle; Univ. of Washington (1970). 84p. University Microfilms Order No. 71-1024.

Thesis.

A study of the reactions between heavy ions was made, motivated originally by the discovery of Yale of strikingly large and regular structure in the elastic scattering cross sections of $^{16}O-^{16}O$ in the energy region 20–30 MeV c.m. The following experiments were performed: 1) Measurements of cross sections for the elastic exit channel and the α exit channels to the 0^+ ground state and 2^+ first excited states of ^{28}Si for the $^{16}O + ^{16}O$ reaction in the energy region of the elastic structure. 2) A good resolution measurement of the elastic scattering in the energy region of the elastic structure. 3) Measurement of $^{18}O - ^{16}O$ elastic scattering cross sections. Studies of previous optical models derived from $^{16}O - ^{16}O$ elastic scattering cross section data were made. It is shown that the elastic structure in $^{16}O + ^{16}O$ is due to grazing collisions. A physically reasonable model which gives a priori estimates of the optical model parameters governing the grazing collisions is presented. The model focuses on configurations directly coupled to the entrance channel. If no directly coupled configurations exist to carry the maximum angular momentum brought in by the entrance channel, the optical model absorptive potential is decreased for those high angular momentum partial waves. (Diss. Abstr. Int., B)

22984 FORM FACTORS FOR VARIOUS DEGREES OF FREEDOM IN THE ^{6}Li NUCLEUS. Kudeyarov, Yu. A.; Kurdyumov, I. V.; Neudatchin, V. G.; Smirnov, Yu. F. (Moscow State Univ.). Nucl. Phys.; A163: 316-36(1971).

In the cluster model for the ^{6}Li nuclei the form factors C0, C2, M1 (elastic and inelastic) and the form factors for the α–d and ^{3}He–t degrees of freedom which have been measured in experiments on the quasi-deuteron absorption of pions and on the quasi-elastic knock-out of ^{3}He or t were calculated. Various effective numbers of nucleon clusters were also calculated. The calculations are based on the antisymmetrized total wave functions ψ in which the wave function of the relative motion of clusters $\phi(R)$ has a shell-model node. The cluster model has proved to be a good tool for describing the whole set of form factors at $q < 1.5-2\ fm^{-1}$. (auth)

22985 DETERMINATION OF THE NUCLEAR MOMENTS OF ^{12}B BY IMPLANTATION IN METAL FOILS. Williams, Robert Lee Jr. Baltimore; Johns Hopkins Univ. (1970). 135p. University Microfilms Order No. 70-26,693.

Thesis.

New measurements of the nuclear spin-lattice relaxation times of ^{12}B implanted in Au, Pd, and Pt have established new lower limits of 60, 185 and 270 sec °K, respectively, of T_1T for ^{12}B in these metals. In conjunction with prior measurements of the effective moment of ^{12}B in these metals, these T_1T values show that the Knight shift of ^{12}B in Au is positive, while in Pd and Pt it is negative. Estimates of the enhancement factors in these metals show that the value of the ^{12}B magnetic dipole moment is (+1.00285 ± 0.00015) nm. Resonance lines of ^{12}B in Mo show that the ^{12}B equilibrium location is on one of the faces of a cubic unit cell, where the local environment has cylindrical symmetry. The Knight shift of ^{12}B in this metal has a large anisotropic component, but there is no detectable electric field gradient at this interstitial site. These lines also show that replacement collisions are extremely unlikely in such a heavy metal. Approximate values of the isotropic and anisotropic Knight shifts of ^{12}B in Mo are 0.135% and 0.109%, respectively. The ^{12}B electric quadrupole moment was measured for the first time using the asymmetry of the ^{12}B resonance lines in Be foil and the known field gradient at ^{9}Be lattice positions. The result is $(+0.037 \pm 0.009) \times 10^{-24}\ cm^2$. These resonance lines also show that replacement collisions are quite likely in this metal and may account for almost half of the implanted nuclei. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 21063, 21064, 22959, 22961, 22962, 22972, 22975, 22981, 23018, 23044, and 23081.

22986 (COO–1120-117) PROGRESS REPORT, SEPTEMBER 1, 1969–AUGUST 31, 1970. (Kansas Univ., Lawrence. Nuclear Structure Lab.). Contract AT(11-1)-1120. 54p. Dep. NTIS.

Progress in the experimental and theoretical nuclear research programs of the University of Kansas in the period Sept. 1, 1969 to August 31, 1970 is reported. The experimental equipment and facilities are described. The staff members and recent publications are listed. (J.W.R.)

22987 (INP–734) PERTURBED ANGULAR CORRELATIONS FOR THE 596–42-keV CASCADE IN ^{62}Cu. Bozek, E.; Golczewski, J.; Hrynkiewicz, A. Z.; Rybicka, M.; Styczen, J.; Polok, G.; Styczen, B. (Institute of Nuclear Physics, Krakow (Poland)). 1970. 8p. Dep. NTIS (U. S. Sales Only).

The perturbation of the directional correlation of the 596–42-keV cascade in ^{62}Cu was measured in external and internal magnetic fields for liquid and metallic (Zn in Ni) sources of ^{62}Zn, respectively. The experiments were performed by the differential and integral methods. An external magnetic field of 13.2 kG was applied in the measurements with the liquid source, and fields of 13.2 kG and 3.0 kG were used in the measurements with the metallic sources. The experimentally determined values of the g factor of the 42-keV state in ^{62}Cu and the internal magnetic field acting on Cu nuclei in the Ni lattice are g = 0.67 ± 0.06 and $H_{Ni}(Cu) = -48.2 \pm 10.4$ kGs. (auth)

22988 E6 AND M5 TRANSITIONS OBSERVED IN /sup 53m/Fe DECAY. Black, J. N.; McHarris, Wm. C.; Kelly, W. H. (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 26: 451-4 (22 Feb 1971).

Photons corresponding to 3040.6-keV E6 and 1712.6-keV M5 transitions have been observed from the decay of 2.6-min ^{53m}Fe. They have intensities of 2×10^{-4} and 7×10^{-3}, respectively, compared with the 701.1-keV E4 isomeric transition that is primarily responsible for depopulating ^{53m}Fe. These correspond to retardations of 650 and 43 over simple single-particle estimates. (auth)

22989 INELASTIC SCATTERING OF 5.8 TO 6.6 MeV PROTONS BY ^{40}Ca. White, R. E.; Willey, H. B. (Univ. of Auckland, New Zealand). Aust. J. Phys.; 23: 475-80(Aug 1970).

Cross sections for the formation of the O^+, 3^-, and 2^+ states in ^{40}Ca at 3.35, 3.74, and 3.90 MeV by inelastic proton scattering were measured at laboratory angles of 90°, 125°, and

140° from 5.8 to 6.6 MeV. Strongly enhanced formation of the 3^- state relative to the 2^+ and 0^+ states is observed between 6.1 and 6.4 MeV. The relationship of this enhancement to the location of 2p-1h states in ^{41}Sc is considered. (auth) (Australia)

22990 BETA DECAY OF ^{23}Mg, ^{27}Si, ^{31}S, ^{35}Ar, AND ^{39}Ca. Detraz, C.; Moss, C. E.; Zaidins, C. S. (Univ. of Colorado, Boulder). Phys. Lett.; 34B: 128-30(1 Feb 1971).

New branches in the β^+ decay of sd-shell A = 4n + 3 nuclei have been observed, and their log ft values determined. Improved upper limits of the branching ratios are reported for unobserved branches. (auth)

22991 THE DECAY OF ^{45}Ti TO ^{45}Sc. Zuk, W. M.; Davidson, W. F.; Najam, M. R.; Awal, M. A. (Australian National Univ., Canberra). Z. Phys.; 242: 93-101(1971).

The low intensity β^+/E.C. branches in the decay of ^{45}Ti to excited states of ^{45}Sc have been reinvestigated in order to resolve discrepancies in reported branching ratios. A new branch to the 974-keV level, having an intensity of $9.9 \pm 1.2 \times 10^{-5}$/decay, has been found. A previously reported branch to the 1237 keV level was found to be in error. The intensities for decay to the levels at 720, 1408 and 1661 keV levels were determined to be 154 ± 12, 90.2 ± 9.7 and 52.5 ± 5.6, respectively, in units of 10^{-5} per decay. (auth)

22992 STUDIES OF PROMPT GAMMA RAYS FROM NEUTRON CAPTURE IN SILICON, IRON, ALUMINUM, CALCIUM, GOLD, LEAD, AND MIXTURES. El Kady, Ahmed Ahmed. College Park, Md.; Univ. of Maryland (1969). 142p. University Microfilms Order No. 70-12,928.

Thesis.

The feasibility of utilizing gamma rays from thermal-neutron capture as a non-destructive technique to determine the elemental composition of rocks and minerals is studied. A high-resolution Ge(Li) detector, about 40 cc, in conjunction with a 1024-channel analyzer measured the high-energy capture γ-ray spectra from silicon, iron, calcium, aluminum, gold, and lead. The resolution was about 12 keV FWHM at 6 MeV. These spectra provided standards for analytical work. Spectra from mixtures of these elements to simulate geological samples were then measured. Element sensitivity curves were constructed by plotting the amplitude of a gamma-ray line characteristic of an element against concentration in the mixture. The quantity I σ/A, "Prompt Gamma-ray Sensitivity Index," provides an indication of the relative sensitivity for using this neutron-capture γ-ray technique; I is the number of γ rays of particular energy per 100 neutrons absorbed in the element, σ is the microscopic cross sections in barns, and A is the mass number. The Sensitivity Indexes for several naturally occurring elements are tabulated. Iron has, perhaps, the highest Index for the major components common in rocks. The indexes are 1.45 at 7.64 MeV for iron, 0.21 at 4.93 MeV for silicon, 0.268 at 6.42 MeV for calcium, 0.204 at 7.72 MeV for aluminum, and 3.45 at 6.25 MeV for gold. Following tests with mixtures of these materials, mostly as oxides, gold ore (about 10 parts per million gold) was tried. The spectrum contained many identifiable peaks. The more prominent lines were used to identify Si, Fe, Al, Ca, Mg, S, Mn, Au, Ba, As, Sr, Cr, Gd, Pb, and Hg. However, ores are complex mixtures of variable and somewhat uncertain composition and interpretation of the spectra is difficult. Nevertheless, the use of this approach to identify gold in trace quantities in geologic materials is considered promising. (TSS) (Diss. Abstr. Int., B)

22993 SIMPLE CHAMBER FOR LIFETIME MEASUREMENTS WITH THE RECOIL-DISTANCE METHOD. Brandolini, F.; Signorini, C.; Kusstatscher, P. (Univ., Padua). Nucl. Instrum. Methods; 91: 341-4(1971).

A simple and versatile set-up to be used for measurements of nuclear lifetimes with the recoil-distance method is described. The distance determination is affected by an error of about 1 μm; i.e., with excited ions with β_{in} = 1%, the chamber enables lifetimes to be measured down to about 5 and 2 ps with 10% and 20% systematic error, respectively. In parallel, a technique for preparing targets with optically flat gold foils as backing was developed. The lifetime of the first $^7/_2$ state in ^{33}S was determined with this set-up as 44 ± 4 ps. (auth)

22994 DOPPLER-SHIFT ATTENUATION MEASUREMENTS IN ^{42}Ca. II. Hartmann, R.; Grawe, H. (Univ., Freiburg i. B.). Nucl. Phys.; A164: 209-18(1971).

The lifetimes of excited states up to E_x = 3.65 MeV in ^{42}Ca were measured by the DSAM. The stopping material was Au. In a pγ angular correlation measurement, the spin of the 3.65 MeV state was found to be $J^\pi = 2^+$, the mixing ratio of its decay to the 1.52 MeV state is δ(E2/M1) = −0.06 ± 0.17. (auth)

22995 REACTION (d,α) ON ^{54}Fe AT 28 MeV. Guichard, A.; Chevallier, M.; Gaillard, P.; (and others) (Univ., Lyon). Nucl. Phys.; A164: 56-68(1971). (In French).

Deuterons accelerated to 28 MeV were used to investigate the (d,α) reaction on ^{54}Fe. Angular distributions, up to an excitation energy of about 4.5 MeV, have been obtained. DWBA calculations have been carried out on the basis of the two-nucleon transfer theory of Glendenning. These results provide information about two-hole states in ^{52}Mn. (auth)

22996 STUDIES OF THE s-SHELLS IN ^{28}Si BY MEANS OF THE (p,2p) REACTION AT 600 MeV. Kullander, S. (CERN, Geneva); Renberg, P. U.; Fagerstroem, B.; (and others). Phys. Lett.; 34B: 197-8(15 Feb 1971).

The 1s and 2s shells in ^{28}Si were studied by means of the (p,2p) reaction at 600 MeV. The angular distribution of the residual nucleus for the 2s shell is anomalous with a minimum in the direction of the incoming proton. (auth)

22997 SHELL MODEL CALCULATIONS IN ^{56}Ni AND ^{54}Fe. Oberlechner, G.; Richert, J. (Centre de Recherches Nucleaires, Strasbourg). Phys. Lett.; 34B: 174-6(15 Feb 1971).

The sensitivity of the theoretically calculated spectra of ^{56}Ni and ^{54}Fe to single-particle-energy variations is analyzed, and the results are compared with those of other authors. (auth)

22998 PROTON DENSITIES IN ^{40}Ca AND ^{48}Ca IN THE HARTREE–FOCK APPROXIMATION. Lande, A. (NORDITA, Copenhagen); Svenne, J. P. Nucl. Phys.; A164: 49-55(1971).

In Hartree–Fock calculations on ^{40}Ca and ^{48}Ca, the rms proton radius of the heavier isotope is found to be smaller than that of the lighter, in agreement with the results of electron-scattering and μ-mesic x-ray experiments. In addition, the surface thickness of ^{48}Ca is found to be smaller than that in ^{40}Ca, again in agreement with experiment. The detailed shape of the calculated density differs considerably from the Fermi distribution used in fitting the data. A discussion of this discrepancy is given. (auth)

22999 INVESTIGATION OF EXCITED NUCLEAR STATES IN ^{68}Zn BY NEUTRON CAPTURE IN ^{67}Zn. Ottmar, H.; Ahmed, N. M.; Fanger, U.; (and others) (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A164: 69-96(1971). (In German).

The electromagnetic transitions between excited nuclear states of ^{68}Zn resulting from thermal neutron capture in ^{67}Zn have been investigated by four different external neutron-beam experiments at the Karlsruhe reactor FR 2. Enriched samples of 89.55% ^{67}Zn and samples of natural ZnO were used as targets. The γ-spectra recorded with high-resolution Ge(Li) anti-Compton and Ge(Li) pair spectrometers revealed more than 400 γ-transitions as originating from ^{68}Zn. Coincidence measurements were performed with a Ge(Li)–NaI(Tl) detector system. The results lead to a considerably extended transition diagram of ^{68}Zn with 49 energy levels many of which were previously unknown both in their existence and in their de-excitation mode. In addition angular correlation measurements were carried out on 7 prominent cascades in the lower part of the decay scheme. The level positions, multipole mixing ratios and γ-branching ratios are discussed in the framework of the vibrational and unified collective models. The neutron-separation energies of the zinc isotopes with masses 65, 67, 68 and 69 were determined to be 7979.2 ± 0.8, 7052.4 ± 0.7, 10198.10 ± 0.50 and 6482.2 ± 0.9 keV respectively. The thermal neutron capture cross sections were derived to 0.85 ± 0.20 b for ^{66}Zn and 6.9 ± 1.4 b for ^{67}Zn. (auth)

23000 MEASUREMENTS OF LIFETIMES IN ^{41}Ca. II. ^{41}K(p,ngamma)^{41}Ca. Laurent, H. (Institut de Physique Nucleaire, Orsay, France); Fortier, S.; Schapira, J. P.; Huck, A.; Walter, G. Nucl. Phys.; A164: 289-99(1971). (In French).

From Doppler shift attenuation measurements in the ^{41}K(p,nγ)^{41}Ca reaction the lifetimes of nine levels in ^{41}Ca have been determined. For the 3050 keV level, a comparison with previous data restricts the spin to $^3/_2$ or $^5/_2$. The measured lifetime of the 3614 keV level excludes M3 character for the ground state transition and confirms a previous assignment $J^\pi = ^3/_2^-$. The results are compared with theoretical calculations. (auth)

23001 MEASUREMENTS OF LIFETIMES IN ^{41}Ca. I. ^{40}Ca(d,pγ)^{41}Ca. Laurent, H. (Institut de Physique Nucleaire, Orsay, France); Fortier, S.; Schapira, J. P.; (and others). Nucl. Phys.; A164: 279-88(1971). (In French).

The Doppler shift attenuation method has been applied to the ^{40}Ca(d,pγ)^{41}Ca reaction to determine the mean lives: τ_m = 460 ± 140, ≥1500, 480 ± 140, 340^{+130}_{-110}, ≤50 and ≤25 fs for the ^{41}Ca levels at E_x = 1943, 2463, 2670, 3050, 3614 and 3945 keV, respectively. (auth)

XUM

23002 FINITE-RANGE DWBA CALCULATIONS FOR (d,^{6}Li) REACTIONS. Smith, W. R. (Trinity Univ., San Antonio, Tex.). Phys. Lett.; 34B: 252-4(1 Mar 1971).

Exact finite-range DWBA calculations are carried out for the ^{32}S(d,^{6}Li)^{28}Si reaction employing optical model parameters obtained from appropriate elastic scattering analyses. The results are in poor agreement with experimental 21-MeV angular distributions. They show a significant dependence on the form of the d−α potential, and they demonstrate the necessity for including $V_d - ^{28}Si - \overline{U}_d - ^{32}S$ interaction term in the transition amplitude in addition to the $V_{d\alpha}$ interaction. (auth)

23003 EVIDENCE FOR GIANT RESONANCE EXCITATION IN MUON CAPTURE. Igo-Kemenes, P.; Deutsch, J. P.; Favart, D.; (and others) (Univ., Louvain, Belgium). Phys. Lett.; 34B: 286-8(1 Mar 1971).

Partial muon capture yields are measured in calcium. Their comparison with the corresponding photo-excitation yields furnishes strong evidence for the analogy of the underlying excitation mechanism. (auth)

23004 MEASUREMENT OF SPALLATION CROSS-SECTIONS FOR 590 MeV PROTONS ON THICK AND THIN TARGETS OF IRON AND NICKEL. Nieschmidt, E. B.; Cline, J. E. (Idaho Nuclear Corp., Idaho Falls). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-17: No. 6, 295-300(Dec 1970).

From Conference on Nuclear and Space Radiation Effects, San Diego, Calif. See CONF-700713.

Gamma-ray pulse-height spectra of products from proton spallation reactions on nickel and iron were measured using a multichannel analyzer and high-resolution Ge(Li) spectrometer system. Spallation cross sections were determined for nickel and iron at 590 MeV proton energy using thin targets and targets sandwiched between thick granite blocks. The results are compared with previous measurements and with calculations made using semiempirical equations. (J.W.R.)

23005 LEVEL STRUCTURE AND DECAY OF THE ^{89}Y NUCLEUS AS INDICATED BY THE STUDY OF GAMMA RAYS FROM INELASTIC NEUTRON SCATTERING. Buchanan, Patricia Sue Maloney. Austin, Tex.; Univ. of Texas (1970). 263p. University Microfilms Order No. 71-101.

Thesis.

The measurement of gamma rays from the (n,n′γ) reaction in ^{89}Y has provided considerable new information regarding the configuration of energy levels in the ^{89}Y nucleus and their mode of decay. Specifically, the gamma ray spectra have indicated gamma ray decays from excited levels at 1.507, 1.745, 2.220, 2.529, 2.568, 2.622, 2.871, 2.881, 3.067, 3.106, 3.138, 3.411, 3.450, 3.502, 3.511, 3.559, 3.625, 3.716, 3.748, 3.852, 3.864, 3.990, 4.027, 4.103, 4.169, 4.185, 4.229, and 4.307 MeV. Differential gamma ray production cross sections at 55° were obtained at incident neutron energies of 3.51, 3.77, 4.00, 4.21, 4.50, 4.75, and 5.00 MeV. Angular distribution determinations were made at 4.00 and 4.75 MeV. The measurements were made with a high resolution 34 cc Ge(Li) spectrometer, utilizing time-of-flight and anticoincidence circuitry to improve the quality of the spectra. Comparisons were made of the experimentally determined gamma ray cross sections and angular distributions with those calculated on the basis of statistical theory corrected for width-fluctuation effects. These comparisons have led to spin and parity assignments for a number of the levels. (Diss. Abstr. Int., B)

23006 SPECTROSCOPY OF f-p SHELL NUCLEI BY (d,n) REACTIONS. Couch, Richard Gerald. Evanston, Ill.; Northwestern Univ. (1970). 115p. University Microfilms Order No. 71-1821.

Thesis.

The ^{54,56}Fe(d,n)^{55,57}Co, ^{59}Co(d,n)^{60}Ni and ^{64,66,68}Zn(d,n)^{65,67,69}Ga reactions were studied at a deuteron energy of 10 MeV by the time-of-flight method. Data were accumulated for all targets at six angles in the range from 18 to 70°. The neutron flight path was about 25 meters at each angle. Absolute differential cross sections were measured and analyzed in terms of the distorted wave Born approximation (DWBA) to determine l-transfers and spectroscopic factors. Spin and parity assignments for several levels are proposed on the basis of the l-values and the transition strengths. The comparison between the spectroscopic factors obtained in these (d,n) experiments and the spectroscopic factors obtained in (^{3}He,d) experiments is discussed in detail. As considered in the usual DWBA formulation, the two reactions should give the same results. Due to the varying methods of analysis which had been applied to the data available in the literature, a direct comparison was inconclusive. For this reason it was necessary to reanalyze several of the (^{3}He,d) data sets. The details of the application of the DWBA method of analysis were examined for both reactions. This study indicated that the (d,n) and (^{3}He,d) reactions can provide the same spectroscopic information, but the agreement of the spectroscopic factors depends in a complicated way on the parameters used in the theoretical analysis. The possible isospin dependence in the (d,n) and (^{3}He,d) reactions is discussed in terms of the analogue state transitions observed in ^{55}Co. No significant discrepancy is observed in the magnitude of the spectroscopic factors obtained by the two reactions for states with different T-values. In the last part the relationship of the experimental results to theoretical models is discussed. A comparison is made with relevant theoretical calculations. In general, only limited agreement is found. (Diss. Abstr. Int., B)

23007 PARTICLE–GAMMA ANGULAR CORRELATIONS IN THE ^{40}Ca(^{3}He,αγ)^{39}Ca AND ^{40}Ca(^{3}He,pγ)^{42}Sc REACTIONS. Anastassiou, George Phoebos. Philadelphia; Univ. of Pennsylvania (1970). 102p. University Microfilms Order No. 70-25,620.

Thesis.

The levels of ^{39}Ca and ^{42}Sc populated in the reactions ^{40}Ca(^{3}He,α)^{39}Ca and ^{40}Ca(^{3}He,p)^{42}Sc, respectively, were studied using the method of particle γ-ray angular correlations. Targets of natural calcium metal, evaporated on a 50 μg/cm^2 carbon backing, were bombarded with ^{3}He^{++} beams. The α-particles and protons were detected at zero degrees with respect to the incident beam by a position sensitive detector located at the focal point of a magnetic spectrometer. Four 7.6 cm × 10.2 cm NaI(Tl) crystals were simultaneously used to detect coincident γ-rays at angles between 90° and 159°. Angular correlations of γ-rays leading to states in ^{39}Ca at 2.47, 2.80, 3.03, 3.66, 3.95 and 4.02 MeV were measured. The spins and parities of the first three excited states were found to be $\frac{1}{2}^+$, $\frac{7}{2}^-$ and $\frac{3}{2}^-$. In conjunction with l-value assignments from DWBA analysis of charged particle angular distributions, the present work assigns $J^\pi = \frac{5}{2}^-$ for the 3.66 MeV state, $\frac{3}{2}^-$ for the 3.95 MeV state, and $\frac{1}{2}^+$ for the state. Multipole mixing and branching ratios were extracted from the data. Angular correlations of γ-rays leading to states in ^{42}Sc at 0.61, 1.49, 1.51, 1.59, and one member of a doublet at 1.88 MeV have been measured. The measurements imply spin 1 for the 0.61 MeV state and for one member of the 1.88 MeV doublet. The best fit to the correlation for the 1.49 MeV state is obtained for spin 3, but other spins cannot be excluded. The 1.51 MeV state decays 100% to the isomeric 7^+ state at 0.62 MeV. The 1.59 MeV state is measured to have spin 2. Multiple mixing and branching ratios were extracted from the data. The relative populations of the M = ±1 and M = 0 magnetic substates were also extracted from the data and compared with a simple direct reaction model. (Diss. Abstr. Int., B)

23008 CHARGE EXCHANGE IN MEDIUM MASS NUCLEI AS OBSERVED BY THE (p,np̄) REACTION. Miller, P. S.; Garvey, G. T. (Princeton Univ., N. J.). Nucl. Phys.; A163: 65-99(1971).

The cross sections for the (p,np̄) reaction, wherein the isobaric analog state of the target nucleus formed by the (p,n) reaction decays by proton emission, was measured as a function of bombarding energy (from 12.8 to 18 MeV) using as target nuclei: ^{67}Zn, ^{77}Se, ^{91}Zr, ^{95,97}Mo, ^{105}Pd, ^{110,111,113}Cd, ^{115,116,117,119}Sn and ^{123,125}Te. The analog state is observed to undergo proton decay (p̄) to the ground state of the residual nucleus in all cases except ^{110}Cd where barrier penetration favors the decay of the first excited state. The fractional width for proton decay, Γ_p/Γ, for the excited analog states is inferred by comparison to ^{92}Mo and ^{115}Sn, which have $\Gamma_p/\Gamma = 1$. These results are compared with the results of resonance experiments. The energy dependence of the cross sections can be reproduced by distorted wave calculations using a consistent charge independent formalism. (auth)

23009 STUDY OF ISOBARIC ANALOG GROUND STATES FOR SEVERAL NUCLEI USING THE (^{3}He,t) REACTION. Fadner, W. L. (Univ. of Colorado, Boulder); Green, R. E. L.; Hayakawa, S. I.; Kraushaar, J. J.; Johnson, R. R. Nucl. Phys.; A163: 203-24(1971).

The (^{3}He,t) reaction was used at 37.7 MeV to investigate the isobaric analogs of the ground states of ^{46}Ti, ^{54}Fe, ^{62}Ni, ^{64}Ni, ^{89}Y, ^{90}Zr, ^{91}Zr, ^{92}Zr and ^{93}Nb. Differential cross sections were measured from 5 to 50°. The angular distributions were described adequately by a macroscopic distorted wave theory. The effect of variations in the optical-model parameters and in the form of the interaction potential was investigated. The strengths of the interaction potentials extracted from the data are compared with values of the asymmetry potential obtained from a recent analysis of ^{3}He and t elastic scattering data. Certain nucleus dependent effects are noted. Coulomb displacement energies were determined for nuclei with A around 90. (auth)

23010 ISOSPIN DEPENDENCE OF THE MASS-3 OPTICAL POTENTIAL FROM THE COMPARISON OF TRITON AND ^{3}He ELASTIC SCATTERING. Urone, P. P.; Put, L. W.; Chang, H. H.;

XUM

Ridley, B. W. (Univ. of Colorado, Boulder). Nucl. Phys.: A163: 225-36(1971).

Differential cross sections were measured for the elastic scattering of 21-MeV ^{3}He particles by ^{40}Ca, ^{52}Cr, ^{54}Fe, ^{62}Ni, ^{64}Ni, ^{90}Zr, ^{92}Zr, ^{94}Zr and ^{118}Sn. These data are compared with recently published 20-MeV triton elastic scattering data for the same targets in a simultaneous optical-model analysis. The strength of the isospin contribution to the optical potential obtained from the elastic scattering studies is compared with that required to describe (^{3}He,t) quasi-elastic scattering data. The major part of the asymmetry dependence previously observed in triton optical potentials is shown to be unrelated to isospin. (auth)

23011 ANGULAR CORRELATION AND LIFETIME MEASUREMENTS ON ^{59}Co. Arens, L.; Koerner, H. J. (Technische Univ., Munich). Z. Phys.; 242: 138-56(1971). (In German).

$\gamma\gamma$ angular correlations and delayed $\beta-\gamma$ coincidences were measured in the decay of ^{59}Fe to ^{59}Co, M1 and E1 transition probabilities were determined for the 143, 192, and 335 keV transition by measuring the 192-1099 keV, 355-1099 keV and 143-1292 keV correlations, and the half-lives of the 1292 and 1434 keV levels. The g-factor of the 1292 keV state was derived to be $g = +1.09 \pm 0.08$ from the perturbation of the 143-1292 keV $\gamma\gamma$ angular correlation in ferromagnetic ^{59}Co Fe and ^{59}Co Ni samples. The results are discussed in terms of the weak coupling model. (auth)

23012 STRENGTH FUNCTION FLUCTUATIONS IN THE MASS REGION OF THE 3s RESONANCE. Mueller, K.-N.; Rohr, G. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A164: 97-112(1971).

Total neutron cross sections of the isotopes ^{49}Ti and ^{53}Cr were measured in the energy range 17 to 250 keV and analyzed with an R-matrix multi-level formula to obtain the resonance parameters. A spin-independent s-wave strength function of (3.2 ± 0.7) 10^{-4} was obtained for ^{49}Ti and $(4.1 \pm 0.9) \cdot 10^{-4}$ for ^{53}Cr. The results above 120 keV indicate a spin dependence of the ^{53}Cr strength function. To investigate the fluctuations of experimental strength function values around the average curve predicted by the optical model, strength functions were calculated for 20 nuclei in the region of the 3s resonance. The calculations are based on a semi-empirical ansatz, and explain the fluctuations as variations of the doorway state density near the binding energy. The density of these states was calculated in the framework of a shell model. Pairing correlations were taken into account according to the superconductivity theory of the nucleus. (auth)

23013 MICROSCOPIC ANALYSIS OF A CHARGE-EXCHANGE REACTION: ^{42}Ca(^{3}He,t)^{42}Sc. Schaeffer, Richard (Univ. of California, Berkeley). Nucl. Phys.; A164: 145-75(1971).

The microscopic description of the (^{3}He,t) reaction is used as a spectroscopic tool. First, an effective interaction is derived and its parameters are deduced from some simple transitions. This interaction is then employed for a microscopic study of the ^{42}Ca(^{3}He,t)^{42}Sc reaction using wave functions with both spherical and deformed components. The nature of the various ^{42}Sc even and odd parity states is discussed, in particular the inhibition of odd parity excitations is examined and a tentative explanation is proposed. (auth)

23014 STUDY OF THE ^{40}Ca(d,n)^{41}Sc*(p)^{40}Ca REACTION. Greenwood, Lawrence Roy. Houston, Tex.; Rice Univ. (1970). 220p. University Microfilms Order No. 70-23,517.

Thesis.

The reaction mechanism of the ^{40}Ca(d,n)^{41}Sc(p')^{40}Ca reaction was studied by an examination of the proton decay of the first excited state in ^{41}Sc at 1.714 MeV. Proton angular distributions were taken with a magnetic spectrometer at 20 energies from $E_d = 3$ to 6 MeV. The shape of these distributions is given by $W(\theta) = 1 + Q_2(E)P_2(\cos\theta)$ where $Q_2(E)$ is an attenuation coefficient given by a weighted average over the ^{41}Sc recoil cone. The measured values of Q_2 fall from near 1 at threshold to about 0.3 at $E_d = 6$ MeV, disagreeing quite badly with a simple geometric or plane wave interpretation. Consequently, the attenuation coefficients were calculated from DWBA theory and were found to agree quite well with the measured values. The DWBA parameters were derived from an optical model analysis of ^{40}Ca(d,d)^{40}Ca data measured at 14 energies from $E_d = 2.5$ to 6 MeV and from a DWBA analysis of ^{40}Ca(d,n)^{41}Sc$_{1.714}$ data measured at ten energies from $E_d = 3.2$ to 6 MeV with time-of-flight apparatus. The DWBA analysis supports the conclusion that the reaction mechanism is almost entirely direct, and that compound nuclear effects make only a minor contribution. The Coulomb distortion of the incident deuteron accounts for most of the observed attenuations, especially near the stripping pole near $E_d = 6$ MeV. However, the deuteron and neutron nuclear distortions are required at all energies to fit the measured attenuation coefficients. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 21394, 22961, 22962, 22986, 22992, 23008, 23009, 23253, and 23338.

23015 (AERE-R-6596) THEORY OF DELAYED NEUTRON PHYSICS. Tomlinson, L. (Atomic Energy Research Establishment, Harwell (England)). Nov 1970. 18p. Dep. NTIS (U. S. Sales Only). UK 3s. 6d.

It is now known that at least 38 of the 500 isotopes formed in fission have the property of delayed neutron emission. The mass regions in which delayed neutron emission occurs are found to be in agreement with the predictions of two recent mass formulas. Partial success has been achieved in relating the delayed neutron emission probability (P_n) of the delayed neutron precursors to basic nuclear parameters—notably, the distance of the precursor from the line of beta-stability and also the "energy window" available for delayed neutron emission. Recent theoretical calculations yielded delayed neutron energy spectra for the 55 and 22 second groups of the same shape as the experimental spectra. It is believed that most of the delayed neutron precursors with half-lives greater than 2 seconds are now known. Using the P_n values of these precursors and calculated cumulative fission yields, it is possible to account for the gross delayed neutron emission from many types of fission. Calculations are given for thermal, fast and 14 MeV fission to illustrate this point. Further significant progress in understanding delayed neutron emission is expected when spectroscopic studies on delayed neutron precursors become possible in the near future. (auth) (UK)

23016 (AERE-R-6642) LIBRARY OF NEUTRON INDUCED FISSION PRODUCT YIELDS MAINTAINED AND INTERROGATED BY COMPUTER METHODS. PART I. THE ESTABLISHMENT OF THE LIBRARY. Crouch, E. A. C. (Atomic Energy Research Establishment, Harwell (England)). Dec 1970. 10p. Dep. NTIS (U. S. Sales Only). UK 2s. 6d.

The first step towards objective assessment of fission product yields is reported in the compilation of a library of all published neutron induced fission product yields, susceptible to computer interrogation and maintenance. The organization of the compilation is explained. (auth) (UK)

23017 (ANL-7749) YIELDS OF FISSION PRODUCTS FOR SEVERAL FISSIONABLE NUCLIDES AT VARIOUS INCIDENT NEUTRON ENERGIES. Flynn, K. F.; Glendenin, L. E. (Argonne National Lab., Ill.). Dec 1970. Contract W-31-109-eng-38. 32p. Dep. NTIS.

This report consists of a summary of recommended values for fission-product yields from fissioning systems pertinent to the physics of reactors based on a survey of the literature through October 1970. Recommended experimental and estimated values for total chain yields in the form of tables and mass-yield curves are presented for neutron-induced fission of ^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{239}Pu, and ^{241}Pu at various neutron energies. (auth)

23018 (AWRE-O-76/66) CROSS SECTIONS FOR (n,2n) REACTION AT 14.7 MeV OF SOME ODD-PROTON NUCLEI. Vallis, D. G. (Atomic Weapons Research Establishment, Aldermaston (England)). 1966. 37p. Dep. NTIS (U. S. Sales Only).

The cross sections of the (n,2n) reactions induced by 14.70 ± 0.15 MeV neutrons in the odd-proton target nuclei: ^{45}Sc, ^{89}Y, ^{93}Nb, ^{103}Rh, ^{169}Tm, ^{175}Lu, ^{203}Tl and ^{205}Tl were measured by the activation method, with particular attention paid to the absolute counting of the activity of the product species. The cross sections were measured relative to an assumed cross section of 120 mb for the ^{27}Al(n,α)^{24}Na reaction and were found to be as follows: ^{45}Sc(n,2n)^{44m}Sc, 122.7 ± 6.0; ^{45}Sc(n,2n)^{44g}Sc, 186 ± 9.3; ^{89}Y(n,2n)^{88}Y, 1052 ± 53; ^{93}Nb(n,2n)^{92}Nb, 502 ± 25; ^{103}Rh(n,2n)^{102}Rh, 586 ± 29; ^{169}Tm(n,2n)^{168}Tm, 1022 ± 65; ^{175}Lu(n,2n)^{174m}Lu, 191 ± 20; ^{175}Lu(n,2n)^{175g}Lu, 844 ± 83; ^{203}Tl(n,2n)^{202}Tl, 1967 ± 120; and ^{205}Tl(n,2n)^{204}Tl, 2307 ± 86, all in mbarns. These results are compared with previously published values, with cross sections predicted by the statistical model, and with those inferred from the systematics of the variation of experimental (n,2n) cross sections with mass number. New values for the half lives of ^{44m}Sc, ^{92}Nb and ^{202}Tl are reported. (34 references) (auth) (UK)

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23019 (EURFNR–862) MICROSCOPIC NEUTRON NUCLEAR DATA AND 5-GROUP CROSS SECTIONS FOR THE ACTINIDES ^{231}Pa, ^{232}U, ^{234}U, ^{236}U, ^{237}U, ^{237}Np, ^{238}Np, ^{236}Pu, ^{238}Pu, ^{241}Am, ^{242}Cm. Hinkelmann, B. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jul 1970. 76p. (KFK–1186; EANDC(E)–128–U). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

A first step is presented in the framework of an accurate systematic evaluation for the following transactinium isotopes: ^{231}Pa, ^{232}U, ^{234}U, ^{236}U, ^{237}U, ^{237}Np, ^{238}Np, ^{236}Pu, ^{238}Pu, ^{241}Am, ^{242}Cm. Microscopic neutron nuclear data were evaluated and 5-group values derived for the radiative capture, the fission, the (n,2n) cross section and for the mean number of neutrons per fission. In the case of lack of experimental data simple systematic methods were applied for the determination of the cross sections. (7 references) (auth)

23020 (EURFNR–880) A MEASUREMENT OF THE FISSION CROSS SECTION OF ^{235}U AT 440- AND 530-keV NEUTRON ENERGY. Kaeppeler, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Nov 1970. 14p. (KFK–1313; CONF-701002–3). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

From EANDC symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

The fission cross section of ^{235}U was measured at two neutron energies using a gas scintillation chamber for registering the fission events and a telescope-like proton recoil detector for determining the neutron flux. The neutrons were produced via the ^{7}Li(p,n)^{7}Be reaction at the Karlsruhe 3 MV pulsed Van de Graaff accelerator. The time of flight method served for background discrimination. At 440 ± 25 keV neutron energy the result was σ_f = 1.17 barns ± 3.5% and at 530 ± 30 keV σ_f = 1.17 barns ± 3.5%. 11 references. (auth)

23021 (JINR–E7–5492) EVIDENCE FOR PARTICLE INSTABILITY OF ^{10}He. Artukh, A. G.; Avdeichikov, V. V.; Gridnev, G. F.; Mikheev, V. L.; Volkov, V. V.; Wilczynski, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 14p. Dep. NTIS (U. S. Sales Only).

The cross section for ^{10}He production in the reaction ^{232}Th (^{15}N – 5 protons) → ^{10}He at E lab (^{15}N) = 145 MeV was estimated from the systematics of the cross sections for multi-nucleon transfer reactions. In the experiment, in which, assuming the particle stability of ^{10}He, about 80 ^{10}He events should be expected, not even a single one has been observed. This result is interpreted as evidence for particle instability of ^{10}He. (auth)

23022 (JINR–P4–5422) MONOPOLE ($I^{\pi} = 0^{+}$) EXCITATIONS IN EVEN–EVEN DEFORMED NUCLEI. A Review Report of the Second Symposium on the Problems of Nuclear Physics, June 12–19, 1970, Novosibirsk. Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 50p. (In Russian). Dep. NTIS (U. S. Sales Only).

The present status of the theoretical and experimental study of the monopole ($I^{\pi} = 0^{+}$) excitations in even nuclei in the ranges $150 \leq A \leq 190$ and $A \geq 228$ is reviewed. The systematics of known experimental data concerning the properties of 0^{+}-states (energies, $\bar{r}$, $\rho(E0)$, B(E2), X, etc.) is given. A number of phenomenological and microscopic descriptions of 0^{+}-states in transitional and strongly deformed nuclei are considered. The properties of β-vibrations, pairing vibrations, spin-quadrupole excitations, coherent pairing fluctuations and of a number of other types of 0^{+}-states are discussed. Attention is paid to the appearance in the spectra of the low-lying ($\omega < 2\Delta$) pairs of 0^{+}-states, their properties being rather different. (auth)

23023 (JINR–P4–5470) SINGLE-PARTICLE ENERGIES, THE SAXON–WOODS POTENTIAL FOR WAVE FUNCTIONS, AND LEVELS OF ODD PARITY NUCLEI OF ACTINIDES. Gareev, F. A.; Ivanova, S. P.; Malov, L. A.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 54p. (In Russian). Dep. NTIS (U. S. Sales Only).

The single-particle state of the Saxon–Woods potential for A = 239 and A = 247 (i.e. for the nuclei in the region of $234 \leq A \leq 250$) was described and energies and wave functions for a series of odd nuclei were calculated taking into account the pair correlations of interactions of superconducting type quasi-particles with phonons. A method is given for resolving Schroedinger equations with Saxon–Woods potential. The behavior of single-particle levels in the A = 239 and A = 247 zones was analyzed and properties of their wave functions are discussed. A calculation method for energy and wave functions of nonrotational states of odd-parity nuclei is described, and energies and the largest components of wave functions for ground and excited states of a series of odd nuclei in the region of $235 \leq A \leq 249$ were found. Properties of nonrotational levels of odd nuclei were analyzed and the energy and wave functions obtained for the single-particle states of Saxon Woods potential for equilibrate deformations. (R.V.J.)

23024 (JINR–P4–5581) ASYMMETRIC DEFORMATION OF FISSIONING NUCLEI. Pashkevich, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 39p. (In Russian). Dep. NTIS (U. S. Sales Only).

The potential energy of a nucleus at large (scission) deformation is calculated by the shell-correction method due to Strutinsky. The shape of the nucleus in the zeroth-order approximation is taken to be the Cassinian ovaloid, the deviation being expanded in a series in Legendre polynomials. Asymmetric shapes of the nucleus are studied. A definition of the Woods–Saxon type nuclear potential is given. The single-particle spectrum, shell correction, liquid-drop energy and total potential energy are calculated. It is shown that the transuranium nuclei are symmetric at the first barrier and in the second minimum of the potential energy. The second saddle point is situated at large asymmetric deformation. The nuclear asymmetry near the scission point is in qualitative agreement with the experimental data on the asymmetry in the mass distribution of the fission fragments. The agreement between the theoretical results and the experimental data on the fission barriers is improved when the asymmetry is taken into account. (auth)

23025 (JINR–P6–5434) INVESTIGATION OF THE ^{175}Hf EXCITED STATES IN THE ^{175}Ta DECAY. Gadjokov, V.; Zvolsky, J.; Molnar, J.;Nenoff, N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

The spectra of the conversion electrons and γ-rays were studied. The experiments on $\gamma-\gamma$ coincidences with 22 γ-lines were performed using Ge(Li) detectors. The decay scheme ^{175}Ta–^{175}Hf with 23 new levels introduced is suggested. The obtained data on ^{175}Hf levels are compared with the theoretical calculations in the framework of superfluid model on the basis of the Saxon–Woods potential. The rotational bands of $7/2^{+}$ /633/, $9/2^{+}$ /624/ and $5/2$ 642 states are introduced among which the Coriolis interaction takes place. (auth)

23026 (JINR–P7–5494) ANGULAR DISTRIBUTIONS AND EXCITATION FUNCTIONS FROM THE (^{15}N,^{16}N), (^{14}N,^{16}N), (^{15}N,^{17}N), (^{14}N,^{17}N) REACTIONS. Artukh, A. G.; Volkov, V. V.; Pomorsky, L.; Tys, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

Angular distributions and excitation functions of the pick-up reactions with one, two and three neutrons were measured in bombarding a number of nuclei with ^{14}N and ^{15}N ions. The boundary character of the studied reactions is established. The dependence of the reaction cross sections on the binding energy of the neutron in the donor-nucleus is obtained. (auth)

23027 (JINR–P7–5495) REGULARITIES OF THE ISOTOPE IN THE MULTINUCLEON TRANSFER REACTIONS. Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E.; Shamsutdinov, A. O. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1970. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

The experimental results on studying the yields of the products from the multinucleon transfer reactions on the Au, Pb and Bi nuclei, while bombarded with the ^{12}C, ^{22}Ne and ^{40}Ar ions, are presented. The angular distributions of some transfer reaction products and the spectra of their kinetic energies were also studied. On the basis of the data obtained, several conclusions are drawn on the mechanism of the multinucleon transfer reactions and qualitative consideration of this mechanism is given. (auth)

23028 (JPRS–52290, pp 66–83) STRUCTURE OF THE CROSS SECTIONS OF ^{238}U IN THE AREA OF UNRESOLVED RESONANCES AS A FUNCTION OF TEMPERATURE. Van'kov, A. A.; Grigor'ev, Yu. V.; (and others). Translated from Studies in Physics and Power Engineering.

The results of an experiment to measure the transmission functions of a neutron beam on uranium samples and to determine their temperature dependence are presented. Preliminary analyses of the data are discussed. (H.D.R.)

23029 (JPRS–52290, pp 109–24) REEVALUATION OF THE FISSION CROSS SECTION OF ^{235}U AND CAPTURE CROSS SECTION OF ^{238}U ON THE BASIS OF AN ANALYSIS OF THE CRITICAL PARAMETERS OF THE ZPR-III CRITICAL MASS FACILITY.

Antonova, L. V.; Bazazyants, N. O.; (and others). Translated from Studies in Physics and Power Engineering.

The changes in the 26th group fission cross sections of uranium-235 and capture cross sections of uranium-238 resulting both from the appearance of new data and from modern analysis of all available microdata for these cross sections are discussed. The results of calculations of the critical mass (K_{eff}) of the ZPR-III assemblies produced using the BNAB system of constants were used. 10 references. (auth)

23030 (N-70-27998) DAISEY: AN EFFICIENT PROGRAM FOR PRODUCTION OF NEUTRON PSEUDO RESONANCE PARAMETER CHAINS IN THE UNRESOLVED ENERGY REGION. Semler, Thor T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1970. 43p. (NASA-TN-D-5837; E-5378). NTIS.

A computer program for efficiently generating neutron pseudo resonance parameter chains is presented. The code DAISY makes use of the central limit theorem to select chains that reproduce average cross section values. The code uses both the chi square and Kolmogorov-Smirnov tests for goodness of fit to produce chains of resonance parameters with the Porter-Thomas and Wigner distribution functions. As an example, the code is used to generate U-238 cross sections in the unresolved resonance region near 20 keV. These continuous cross sections are used to calculate the Doppler effect, and to estimate the s-wave, p-wave overlap effects at 20 keV. The computed Doppler coefficient for U-238 at 20 keV is consistent with other theoretical calculations for both a thin foil and a thick sphere. (auth) (STAR)

23031 (ORNL-4638) CROSS SECTIONS FOR HYDROGEN AND HELIUM PARTICLES PRODUCED BY 62- AND 39-MeV PROTONS ON ^{209}Bi. Bertrand, F. E.; Peelle, R. W. (Oak Ridge National Lab., Tenn.). Jan 1971. Contract W-7405-eng-26. 70p. Dep. NTIS.

Tabulated differential cross sections are presented for the production spectra of proton, deuteron, triton, helium-3, and alpha particles from ^{209}Bi bombarded by 62-MeV protons, and for all particles but ^{3}He for incident 39-MeV protons. Continuum cross sections in ~1-MeV bins are listed for 18 angles for 62-MeV incident protons, and for four angles for 39-MeV protons. The low-energy cutoffs range from 4 to 15 MeV for the different exit particle types. Angular distributions for 62-MeV incident protons are given for excitations in ^{209}Bi at 0, 1.62, 2.65, 3.15, 3.56, 3.96, 4.29, 5.20, and 5.49 MeV, and comparisons are made with DWBA theory. The energies, strengths, and angular momentum transfers obtained for the ^{209}Bi collective groups approximate those for the collective levels of ^{208}Pb. In ^{209}Bi angular distributions are given for multiplets observed with 62-MeV protons at excitation energies of 0.030, 0.635, 1.02, 1.73, 2.42, and 3.48 MeV. Only elastic scattering cross sections are given for incident 38.8-MeV protons, since there is an inadequate amount of data for angular distributions. Definite evidence is found for (p,np) reactions in the 90-deg proton spectrum for 39-MeV incident protons, and a value for the ^{209}Po-^{209}Bi Coulomb displacement energy of 18.9 ± 0.1 MeV is obtained from these data. (auth)

23032 (ORNL-tr-2405) NEW ISOMER OF ^{110}Rh(T $\frac{1}{2}$ = 28 s). Pinston, J. A.; Schussler, F. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.) from Nucl. Phys.; A144: 42-52 (1970). 11p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 35882.

23033 (ORO-3924-5) ANGULAR MOMENTUM EFFECTS IN NUCLEAR REACTIONS. Progress Report, January 1-December 31, 1970. Natowitz, J. B. (Texas Agricultural and Mechanical Univ., College Station. Cyclotron Inst.). Contract AT-(40-1)-3924. 10p. Dep. NTIS.

Studies of angular momentum effects in nuclear reactions were continued with emphasis on the probability of compound nucleus formation and with studies of the evaporation of α particles in the de-excitation of ^{120}Te. Investigations of fission isomerism and α decay in the neutron deficient Am isotopes were also continued. The first chance fission of ^{198}Hg was explored by the measurement of fission fragment angular distributions from the reaction ^{197}Au(p,f). The division of the available kinetic energy between neutrons and gamma rays in the reactions ^{93}Nb(α,2n)^{95}Tc and ^{93}Nb(α,3n)^{94}Tc was determined. Related research on a study of the reaction ^{209}Bi(α,p)$^{212m+g}$Po is summarized briefly as is collaborative research in the area of x-ray emission induced by charged particles. An appendix presents the ratios of x-ray yields from the irradiation of Ti, Cu, and Au targets with alpha particles and deuterons of identical velocity between 6.25 and 20 MeV/amu. (auth)

23034 THE DECAY OF THE ^{136}I ISOMERS TO THE ENERGY LEVELS OF ^{136}Xe. Lundan, A. (Helsinki Univ. of Tech., Otaniemi, Finland). Z. Phys.; 242: 107-20(1971).

The gamma spectra associated with the decay of the ^{136}I isomers have been measured by means of a Ge(Li) detector. The iodine samples were produced by using the technique of on-line isotope separation of the fission products of a ^{235}U target at the R2-O reactor in Studsvik, Sweden. On the basis of the measured singles and Ge-Ge coincidence spectra a new level scheme was constructed for ^{136}Xe. A comparison with theoretical calculations is included. The half-life analysis of the gamma peaks as well as the beta and K x-rays associated with mass 136 iodine showed that there exist three separate half-lives: 48 ± 2 s, 83 ± 3 s and 100 ± 3 s, the last one being not previously reported. The possibility of the existence of three isomeric states in ^{136}I is discussed. (auth)

23035 NEUTRON SCATTERING CROSS SECTIONS OF ^{233}U, ^{235}U, AND ^{239}Pu. Simpson, F. B. (Idaho Nuclear Corp., Idaho Falls); Miller, L. G.; Moore, M. S.; Hockenbury, R. W.; King, T. J. Nucl. Phys.; A164: 34-48(1971).

Resonance neutron-scattering cross sections have been measured for ^{233}U, ^{235}U and ^{239}Pu targets below a few hundred eV neutron energy. Resonance spins have been determined for (^{239}Pu + n) for resonances below 120 eV, and for (^{235}U + n) for resonances at 8.8, 11.7 and 19.3 eV. For the most part, these resonance spin assignments agree well with previous work. The resonance scattering cross section of ^{233}U appears to be anomalously large, and here spin assignments were not possible. (auth)

23036 SINGLE-PARTICLE PROTON ADMIXTURES IN CORE-EXCITED STATES OF ^{207}Bi. Glashausser, C. (Rutgers-The State Univ., New Brunswick, N. J.); Hendrie, D. L.; McClatchie, E. A. Phys. Lett.; 34B: 199-201(15 Feb 1971).

At least 18 states up to 3.5 MeV in excitation were observed in the ^{206}Pb(^{3}He,d)^{207}Bi reaction at 35 MeV. The experimental spectrum and spectroscopic factors are in fair agreement with the predictions of the weak-coupling model up to an excitation energy of 2.5 MeV. (auth)

23037 ^{177}Lu RADIATION SPECTRA TAKEN DURING THERMAL NEUTRON RADIATIVE CAPTURE. Beitin, M. R.; Bondarenko, V. A.; Kramer, N. D.; Prokof'ev, P. T.; Manfrass, P.; Prade, Kh. (Inst. of Physics, Riga. Central Inst. for Nuclear Research, Berlin). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 4, 3-18(1970). (In Russian).

The spectrum of the conversion electrons emitted by the reaction ^{176}Lu (n,γ) ^{177}Lu was measured by means of a β spectrograph with the resolution 0.1 to 0.3%. The γ-ray spectrum of the same reaction was measured by means of a 10-cm^3 Ge(Li) detector with a resolution of 4 keV at 50 keV and 8 keV at 3 to 6 MeV. Both spectra were obtained in the region of transition energies from 50 to 2050 keV. In addition, the γ-ray spectrum is recorded in the energy region from 4870 to 6800 keV. Many new transitions were found as the result of measurements. Multipolarities are determined for the majority of transitions. (auth)

23038 EVIDENCE FOR OBLATE DEFORMATION OF THE 9/2$^-$ ISOMETRIC STATE IN ^{199}Tl. Nakai, K. (Univ. of California, Berkeley). Phys. Lett.; 34B: 269-70(1 Mar 1971).

The possibility is discussed of deducing the sign of the intrinsic quadrupole moment of a nucleus from the sign of the measured mixing ratio of E2-M1 transitions in a rotational band. By this method experimental confirmation is pointed out for the previously proposed oblate deformation of the 9/2$^-$ state in ^{199}Tl. (auth)

23039 ON THE NUCLEAR EQUILIBRIUM DEFORMATION AND THE MOMENT OF INERTIA OF THE 11/2$^-$ [505] BAND. Hjorth, S. A.; Oppelstrup, J.; Ehrling, G. (Research Inst. for Physics, Stockholm). Phys. Lett.; 34B: 255-6(1 Mar 1971).

Observations on rotational energies within the 11/2$^-$ [505] band in ^{155}Gd and ^{161,163,165}Er suggest that the pairing correlations are weaker and that the nuclear equilibrium deformation is larger in these bands than in the ground bands of the adjacent even nuclides. (auth)

23040 AXIAL ASYMMETRIC FISSION-BARRIER DISTORTIONS. Schultheis, Hildegard; Schultheis, R. (Univ., Munich). Phys. Lett.; 34B: 245-8(1 Mar 1971).

Potential-energy surfaces of even actinides are calculated according to tri-axial ellipsoids by a modified Myers-Swiatecki energy formula. The curve of minimum energy connecting the ground state and the second hump of the fission barrier corresponds to nonaxial distortions. (auth)

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23041 (γ,p) CROSS SECTION IN ^{206}Pb. Dahmen, H.; Dreyer, F.; Staude, J.; Thies, H. H. (Univ., Heidelberg). Nucl. Phys.; A164: 140-4(1971).

The (γ,p) cross section in ^{206}Pb was measured from threshold to 33 MeV, using bremsstrahlung from a 33 MeV betatron, and the induced activity in ^{205}Tl was observed. The cross section shows detailed structure above a continuous background, in particular a prominent peak at 25 MeV which may be interpreted as due to an E1, ΔT = 1 transition to an isobaric analogue state. The integrated cross section from threshold to 33 MeV was 26.8 ± 0.4 MeV · mb. (auth)

23042 BAND STRUCTURE OF ODD-A RHENIUM ISOTOPES BY PROTON STRIPPING REACTIONS. Lu, Ming Taw. Rochester, N. Y.; Univ. of Rochester (1970). 174p. University Microfilms Order No. 71-1406.

Thesis.

The intrinsic proton states of ^{183}Re, ^{185}Re and ^{187}Re were studied by means of the (^{3}He,d) and (α,t) reactions on ^{182}W, ^{184}W and ^{186}W, respectively. Transfer l-values were determined by a comparison of cross sections in the two reactions for all three targets, and from angular distributions in the (^{3}He,d) reaction for ^{182}W and ^{186}W. Spectroscopic strengths were determined from a comparison with DWBA calculations for both reactions with generally good agreement for relative strengths. The present results provide good evidence for assignment of the following intrinsic states in all three nuclei: $\frac{5}{2}$ + [402], $\frac{9}{2}$ − [514], $\frac{1}{2}$ + [400] plus ($K_0 - 2$) γ-vibration, $\frac{3}{2}$ + [402], $\frac{1}{2}$ − [541] and $\frac{11}{2}$ − [505]. The last band may be mixed with an octupole vibrational state. The $\frac{1}{2}$ + [411] band is also observed in ^{185}Re and ^{187}Re through Coriolis coupling with the $\frac{3}{2}$ + [402] band. The present results are consistent with the assumption of strong mixing between the bands $\frac{1}{2}$ + [400], $\frac{1}{2}$ + [660] and between $\frac{3}{2}$ + [402], $\frac{3}{2}$ + [651]. The magnitude of the mixing is considerably larger than is predicted by calculations assuming only quadrupole deformations. It is concluded that the simple Nilsson model provides a very good description of the observed structure up to an excitation of about 1500 KeV, but the structure is much more complex at higher energies. (Diss. Abstr. Int., B)

23043 s-WAVE AND p-WAVE RESONANCE NEUTRON CAPTURE IN ^{91}Zr, ^{93}Nb, AND ^{103}Rh. Rimawi, Karim A. R. Albany; State Univ. of New York (1969). 187p. University Microfilms Order No. 70-25,475.

Thesis.

Measurements of both thermal and slow neutron resonance capture in ^{91}Zr, ^{93}Nb and ^{103}Rh were made, using a fast chopper facility. Since these nuclei lie in the mass region of the p-wave strength function maximum, it was possible to study p-wave resonance capture, as well as, s-wave resonance capture in the case of the target nuclei ^{91}Zr and ^{93}Nb. The spectral shape is seen to differ for the two groups of resonances in niobium. This difference in the spectral shape was found sufficient to explain the measured difference in the total radiation widths of s-wave and p-wave resonances in ^{94}Nb. A model, in which doorway state effects contribute largely to the radiative capture process in p-wave levels, is proposed. Transitions to a group of states near 1 MeV in ^{104}Rh were seen to be enhanced. Application of the same model to explain the enhancement of these transitions as due to doorway state effects was found to result in the requirement that these transitions are of M1 multipolarity. Spin assignments were made for both capturing and low lying states in the nuclei studied in the experiment. (Diss. Abstr. Int., B)

23044 A METHOD FOR THE HIGH PRECISION MEASUREMENT OF RELATIVE INTENSITIES AND INTERNAL CONVERSION COEFFICIENTS IN THE DECAYS OF ^{192}Ir, ^{51}Cr, ^{207}Bi, AND ^{137}Cs. Willett, James Bernard. Bloomington, Ind.; Indiana Univ. (1969). 121p. University Microfilms Order No. 70-12,412.

Thesis.

The development of a method for the precision measurement of relative intensities and internal conversion coefficients is discussed. The success of this method primarily depends on a series of interconnecting computer analysis routines which are designed to preserve the significance of the propagated uncertainties. High precision fitting is used to determine photopeak and conversion line intensities. A pair of relative efficiency curves are derived, one for gamma rays and one for electrons, with the property that the ratio of the electron efficiency to the gamma-ray efficiency is known absolutely. The gamma-ray efficiency curve is determined by the point-pair method, and the electron efficiency curve is determined from the gamma-ray curve by a set of internal conversion standards. Relative electron and gamma-ray intensities are determined from their respective curves and the uncertainties in the intensities are given in their complete matrix form. Internal conversion coefficients are determined directly from the absolute ratio of the two efficiency curves. These analysis procedures were applied to data taken from the decays of ^{192}Ir, ^{51}Cr, ^{207}Bi, and ^{137}Cs. The relative gamma-ray intensities in ^{192}Ir are found to be in general agreement with previous measurements with one exception. The 468-keV gamma-ray is found to be 5–8% lower in intensity relative to the 316-keV line than in most previous measurements. However, a comparison of transitions feeding the 316-keV first excited state with the 316-keV gamma-ray intensity, using recent values of internal conversion coefficients, shows agreement to better than 0.5%, whereas earlier measurements show 2–11% excessive feeding. Relative electron intensities and internal conversion coefficients, for both the K- and L-shells, are determined for the 468-keV, 484-keV, 589-keV, 604-keV and 612-keV transitions following the decay of ^{192}Ir. These results are compared with recent theoretical values, and the E2/M1 mixing ratio of the 604-keV transition is redetermined. The K-conversion coefficients were measured for the 320-keV transition in ^{51}V and the 662-keV transition in ^{137}Ba. The 320-keV measurement is $(1.527 \pm 0.036) \times 10^{-3}$ which is in agreement with earlier measurements of the total conversion coefficient. The K-conversion coefficient of the 662-keV transition was found to be $(9.22 \pm 0.22) \times 10^{-2}$ which is in very close agreement with the most recent measurement of this transition. Previous high precision measurements have not been entirely consistent. A precision measurement of the 1063/570 relative intensities in ^{207}Pb was made, giving a ratio of 0.7770 ± 0.0045. This value is in agreement with most earlier results although the precision in this case is significantly greater. (Diss. Abstr. Int., B)

23045 DECAY STUDIES OF SEVERAL MEDIUM-WEIGHT NEUTRON DEFICIENT NUCLEI. Doron, Ted Arie. Rochester, N. Y.; Univ. of Rochester (1970). 100p. University Microfilms Order No. 71-1378.

Thesis.

Gamma spectra following the ^{104}Cd, ^{104,104m}Ag, ^{104,104m}Rh and ^{96,96m}Rh decays were studied using a high resolution, 32cc Ge(Li) detector. Two unreported gamma rays with energies of 625.2 and 709.2 keV were observed following the decay of ^{104}Cd. These two transitions together with the previously known ones are included in a proposed decay scheme. Accurate energies and relative intensities of more than 70 previously unreported gamma rays from the decay of ^{104,104m}Ag are listed. Several unreported gamma transitions following the decay of ^{104,104m}Rh were observed. Most of the 90 gamma rays of the decays of ^{104,104m}Ag and all of the gamma rays of the decay ^{104,104m}Rh are placed in a proposed decay scheme. In addition to the three gamma rays already reported in the literature more than ten yet unreported transitions were observed following the decay of ^{96,96m}Rh. The majority of the gamma transitions from the decay of ^{96,96m}Rh were placed in the proposed decay scheme. Proton inelastic scattering on ^{104}Pb was measured to obtain the energies of the levels in this nucleus. The 0^+, 2^+, 4^+ two phonon triplet of ^{104}Pd at 1.3 MeV was well resolved. Also the previously unreported 3^-, one phonon octupole vibrational level was seen at 2.192 MeV. Alpha inelastic scattering was measured on ^{96}Ru. Levels at .83, 1.52, 2.15, 2.86 and 3.10 MeV were observed. Comparison of some characteristics of the vibrational levels of even–even palladium and cadmium nuclei are discussed. Some characteristics of ^{104}Pd and other even mass palladium and cadmium isotopes are compared to the collective spherical vibrational model. (Diss. Abstr. Int., B)

23046 MULTIGROUP ELASTIC SCATTERING CROSS SECTIONS FOR HEAVY ELEMENTS. Henryson II, Herbert '(Argonne National Lab., Ill.). Nucl. Sci. Eng.; 43: 235-7(Feb 1971).

An approximate method for calculating heavy element elastic scattering transfer matrices for use in multigroup reactor codes is presented. Semianalytic expressions for evaluating the scattering matrix elements for heavy elements are given. When used in conjunction with the MC^2 algorithm for light elements, the method provides fast and accurate evaluation of multigroup elastic scattering matrices. (J.W.R.)

23047 RADIOCHEMICAL STUDY OF PRODUCTS OF FISSION OF URANIUM IRRADIATED BY ACCELERATED ARGON IONS. Gvozdev, B. A.; Gyrd, E.; Ionesku, S.; Sabeu, K.; Spiridon, S. Radiokhimiya; 12: 612-17(1970). (In Russian).

Mass and charge distributions and yields were from the fission of the Z = 110 compound nucleus formed in the bombardment of ^{238}U with a 270-MeV ^{40}Ar beam were measured. The results are given and the separation methods used in isolating the fission products are discussed. (J.W.R.)

23048 QUASIPARTICLE INTERACTIONS IN THE SPHERICAL N = 82 DOUBLY EVEN NUCLEI. Waroquier, Michel; Heyde, Kris (Rijksuniversiteit, Ghent). Nucl. Phys.; A164: 113-39(1971).

Shell-model calculations for the doubly even single-closed-

shell nuclei with N = 82 neutrons are performed by using a surface delta interaction (SDI) and a Gaussian force as the residual nucleon–nucleon interaction. The resemblance with the Tabakin force is discussed. The single-particle energies are determined by solving the inverse-gap equations (IGE). The shell-model Hamiltonian is diagonalized in a two-quasiparticle space after elimination of the spurious states. The RPA approach is discussed too. Also electric quadrupole and magnetic dipole transitions and static moments are calculated. The calculated spectroscopic factors are studied and compared with the experimental one-nucleon transfer data. (auth)

23049 NUCLEAR STRUCTURE STUDIES IN ^{133}Cs AND ^{103}Rh. Frey, George Donald. Columbia, S. C.; Univ. of South Carolina (1970). 89p. University Microfilms Order No. 70-049.
Thesis.

Work done on the nuclear structure of ^{133}Cs and ^{103}Rh is reported Directional-correlation and internal-conversion measurements were used to investigate the penetration effect in ^{133}Cs. The following directional correlations and correlation coefficients were measured: $W(356\gamma - 81\gamma) = 1 + (0.0355 \pm 0.0037)P_2(\cos\theta) + (0.000 \pm 0.008)P_4(\cos\theta)$; $W(276\gamma - 161\gamma) = 1 - (0.0420 \pm 0.009)P_2(\cos\theta) - (0.028 \pm 0.010)P_4(\cos\theta)$; $W(276\gamma - 161e_{K-}) = 1 - (0.256 \pm 0.020)P_2(\cos\theta) - (0.090 \pm 0.025)P_4(\cos\theta)$; $A_2(276e_{K-} - 161\gamma) = -0.7 \pm 0.1$; and $A_2(301e_{K-} - 81\gamma) = 0.003 \pm 0.008$. Two internal-conversion coefficients were measured also, $\alpha_K(81)$ was found to be 1.46 ± 0.05 and $\alpha_{L+M+N}(81)$ was found to be 0.314 ± 0.020. These data were then used to determine the penetration parameter (λ) for three of ^{133}Cs transitions. The values of λ were found to be: $\lambda(81) = -2.8 \pm 2.3$; $\lambda(161) = 41 \pm 6$; and $\lambda(303) = -2.0$. The decay of ^{103}Ru was studied in order to clarify the ^{103}Rh decay scheme. The K-shell conversion coefficient for the 53-keV and 497-keV transitions were measured directly. $\alpha_K(53)$ was found to be 2.47 ± 0.14 and $\alpha_K(497)$ was found to be 0.0044 ± 0.0002. The intensities of the gamma rays and conversion electrons for the 444, 497, 557 and 610-keV transitions were measured. These intensities were used to obtain: $\alpha_K(444) = 0.0064 \pm 0.0027$; $\alpha_K(557) = 0.0037 \pm 0.0007$; and $\alpha_K(610) = 0.0027 \pm 0.0003$. The existence of the weak line at 242-keV was confirmed. Finally, the following directional-correlation coefficients were determined: $A_2(444\gamma - 53\gamma) = 0.133 \pm 0.024$; and $A_2(557\gamma - 53\gamma) = 0.120 \pm 0.020$. The data indicate an M1 assignment for the 497-keV transition. The data also indicate spins of $^1/_2^+$, $^5/_2^+$ and, $^5/_2^+$ or $^7/_2^+$ for the levels of 93, 537 and 650-keV, respectively. (Diss. Abstr. Int., B)

23050 ENERGY LEVELS OF ^{155}Gd AND ^{157}Gd POPULATED BY THE (d,d) REACTION. Sterba, F.; Tjoem, P. O.; Elbek, B. (Univ. of Copenhagen). Nucl. Phys.; A162: 353-64(1971).

The inelastic scattering of deuterons from ^{155}Gd and ^{157}Gd was studied. The data supplement the information previously obtained about the low-lying levels in these isotopes from (d,p) and (d,t) reactions. The (d,d′) spectra were recorded at a deuteron energy of 12 MeV in a high-resolution magnetic spectrograph at 60, 90 and 125°. The inelastic scattering cross sections are discussed in terms of collective vibrational excitations and the Coriolis coupling of single-particle states. (auth)

23051 THE DECAY OF ^{123}Xe. Stippler, R. (Technische Univ., Brunswick); Lode, D.; Schrader, H.; Muennich, F. Z. Phys.; 242: 121-37(1971).

The decay scheme of 2.1 h ^{123}Xe was investigated using isotopically separated samples produced by the ISOLDE facility at CERN. A total number of 108 γ-transitions were observed in this decay, 103 of them were placed in a level scheme involving 28 excited states in ^{123}I. This level scheme is mainly based on the results of $\gamma\gamma$-coincidence experiments with two Ge(Li) detectors. (auth)

23052 INVESTIGATION OF STATISTICALLY PERTURBED ANGULAR CORRELATIONS OF ^{181}Ta AT DIFFERENT TEMPERATURES. Schmidt, G.; Wagner, H. F. (Univ., Bonn). Z. Phys.; 242: 102-6(1971).

The attenuation of the 133–482 keV cascade of ^{181}Ta in hydrofluoric acid at different temperatures was time differentially investigated. Using a four detector apparatus measurements with eight fold statistics were made. As a result a small attenuation at room temperature which was increased with decreasing temperature of the liquid source was found. A comparison of $A_2(0)$ and $A_4(0)$ values with the results of other authors is given. (auth)

23053 TRANSITION PROBABILITIES IN ^{99}Tc. McDonald, J. (Swedish Research Councils' Lab., Studsvik); Baecklin, A.; Malmskog, S. G. Nucl. Phys.; A162: 365-75(1971).

Transitions between low-lying states in ^{99}Tc, the $^5/_2^+$ state at 181.1 keV, the $^7/_2^+$ state at 140.5 keV and the $^9/_2^+$ ground state were studied from the β-decay of ^{99}Mo. A double-focusing β-spectrometer was used to study conversion electrons. From L-subshell ratios the 140.5 keV transition was found to be 96% M1 + 4% E2 and the 40.6 keV transition was found to be 98.6% M1 + 1.4 E2. From the electron measurements it was deduced that the 40.6 keV γ-ray has an intensity of $1.05 \pm 0.16\%$ of the 140.5 keV γ-ray. The half-life of the 140.5 keV level was measured directly using a long-lens electron coincidence spectrometer. A value of $T_{1/2} = 160 \pm 20$ ps was obtained. The half-life of the 181.1 keV level was redetermined and found to be $T_{1/2} = 3.61 \pm 0.07$ ns. Five reduced transition probabilities were deduced. Two of the E2 rates are enhanced more than 50 times, and it is shown that the properties of the levels cannot be explained by models which assume that the nucleus is spherical. The data are interpreted in terms of a proposed oblate deformation of ^{99}Tc. (auth)

23054 NEUTRON HOLE STATES IN ^{137}Ba, ^{139}Ce, ^{141}Nd, AND ^{143}Sm. Chaumeaux, A.; Bruge, G.; Faraggi, H.; Picard, J. (CEN, Saclay, France). Nucl. Phys.; A164: 176-90(1971).

Single neutron hole states in neutron magic N = 82 nuclei were investigated using the (p,d) pick-up reaction on ^{138}Ba, ^{140}Ce, ^{142}Nd and ^{144}Sm with 24.55 MeV protons and about 45 keV overall energy resolution. Energy levels corresponding to the shell-model orbitals $2d_{3/2}$, $3s_{1/2}$, $1h_{11/2}$, $2d_{5/2}$ and $1g_{7/2}$ were observed in all the residual nuclei. Absolute or relative differential cross sections measured between 15 and 80° in 5° steps were compared with DWBA calculations. All the excitation spectra investigated show similar features characteristic of pure neutron hole states for the low-lying $^3/_2^+$, $^1/_2^+$ and $^{11}/_2^-$ states and of configuration mixing above 1 MeV excitation energy for the $2d_{3/2}$ and $1g_{7/2}$ orbitals. For ^{144}Sm the polarized proton beam was used to confirm some spin assignments. Evidence for the neutron–proton interaction effect on the location of the various orbitals is shown. (auth)

23055 UNIFIED NUCLEAR MODEL DESCRIPTION OF PROPERTIES OF THE LOW-LYING LEVELS IN ODD MASS CESIUM ISOTOPES. Friedman, Josef Neil. Brooklyn; Polytechnic Inst. of Brooklyn (1970). 121p. University Microfilms Order No. 70-26,048.
Thesis.

The properties of the low-lying levels in the odd-mass cesium isotopes are investigated within the framework of the intermediate coupling approach in the unified nuclear model. The calculations are performed by assuming: 1) the coupling of the last odd proton which has available to it $2nd_{3/2}$, $1g_{7/2}$ and $2d_{5/2}$ states to the quadrupole vibrations of the neighboring even–even ^{130}Xe core for ^{131}Cs nucleus; and 2) the coupling of the three proton holes in the $1g_{7/2}$ subshell which can take $(1g_{7/2})^{-3}_{7/2}$ and $(1g_{7/2})^{-3}_{5/2}$ states to the quadrupole vibrations of the even–even ^{136}Ce and ^{138}Ce cores for ^{133}Cs and ^{135}Cs nuclei respectively. In addition a possible $2d_{5/2}$ proton excitation state and its coupling to the quadrupole vibrations of the even–even ^{132}Xe and ^{134}Xe cores are also considered for ^{133}Cs and ^{135}Cs nuclei respectively. The excitations of each of the above cores are described by means of the collective quadrupole phonons since every one of these even–even cores exhibits characteristics of the vibrational spectrum of quadrupole type for the low-lying levels. The resulting total Hamiltonian of the coupled system is diagonalized including all states with up to three phonons for spins from $^1/_2$ to $^{11}/_2$ in the space of the basis eigenvectors of the uncoupled system. With reasonable values for the coupling strength, for the quadrupole phonon energy, and for the effective relative particle (hole) excitation energies, the calculated energy spectra for the low-lying levels of ^{131}Cs, ^{133}Cs and ^{135}Cs and their spins and parities are in fairly good agreement with the experimental data. Further, the wave-functions obtained from the model are used to calculate the electromagnetic transition probabilities, the mean lifetimes, the electric quadrupole and magnetic dipole moments for several of the low-lying levels of the nuclei investigated. These calculations were performed both with the free nucleon values of the electric charge and spin gyromagnetic ratio and with their effective values. These results of the calculations are also in substantial agreement with the available experimental data. The results with the effective charge and spin gyromagnetic ratio give an improved agreement between theory and experiment for ^{133}Cs and ^{135}Cs. In particular, the sign change of the ground state quadrupole moment, which is experimentally observed in the odd-mass cesium nuclei, as one goes from mass number 131 to 135 strongly indicates that the nature of the coupling changes from core-particle to core-hole. The calculations support this observation. The results of the model calculations are also compared with the other theoretical works available. Finally the validity of the approximations used in the present analysis, the possible reasons for some of the discrepancies between the theoretical and experimental results and the circumstances in which more extensive experimental investigations are discussed. (Diss. Abstr. Int., B)

XUM

23056 WEAK INTERACTION STUDIES BY NUCLEAR ORIENTATION. Brewer, William Dean. Berkeley, Calif.; Univ. of California (1970). 215p. University Microfilms Order No. 71-750. Thesis.

The technique of low temperature nuclear orientation was applied to two problems involving weak nuclear decays. Nuclei of ^{119}Sb were polarized in an iron lattice and the angular distribution of inner bremsstrahlung photons emitted during the electron-capture decay was observed. The distribution fit the correlation function $W(\theta) = 1 + A_1G_1P_1 (\cos \theta)$ and the asymmetry coefficient had the theoretical value of +1.0 near the spectrum endpoint. However, some energy dependence of A_1 was observed, in contrast to theoretical expectations. Possible origins of the energy dependence are discussed. Nuclear orientation was also carried out with three isotopes which undergo 1st forbidden beta decays: ^{186}Re, ^{188}Re, and ^{194}Ir. The source nuclei were polarized in iron lattices and the angular distributions of both beta particles and gamma rays were observed. Lithium-drifted germanium counters were used to detect the beta particles. The beta particle angular distribution coefficients A_1 and A_2 are reported as functions of energy. The results are in general agreement with those of previous workers, although the experimental errors have been considerably reduced. The attenuation of the gamma ray anisotropies gives a measure of the relative size of the $\int B_{ij}$ matrix element in the preceding $1^- \rightarrow 2^+$ beta decays and values for the attenuation are reported. The $\int B_{ij}$ matrix element was found to make a finite contribution in the decays of the two Re isotopes, but to be zero in the ^{194}Ir decay. The combined data may be used to determine the nuclear matrix elements entering the decays and to test the Conserved Vector Current hypothesis of weak interactions. (Diss. Abstr. Int., B)

Nuclear Theory

Refer also to abstracts 22354, 22819, 23010, 23048, and 23334.

23057 (AD-712728) NUCLEAR STRUCTURE STUDIES USING NUCLEON AND MESON INTERACTIONS. Final Scientific Report. Wilkinson, D. H. (Oxford Univ. (England). Dept. of Nuclear Physics). 30 Jun 1970. Contract F61052-67-C-0104. 13p. (AFOSR-70-2396-TR). NTIS.

Information on nuclear structure was obtained in terms of the shell and collective models from data on energy levels, transition rates and multipole moments and on the interpretation of scattering and stripping experiments performed on the Oxford accelerators and elsewhere. (auth) (USGRDR)

23058 (LA-4386-TR) DOUBLE-HUMPED BARRIER IN THE QUASI-CLASSICAL APPROXIMATION. Gai, E. V.; Ignatiuk, A. V.; Rabotnov, N. S.; Smirenkin, G. N. Translated by Anna Vakar (Los Alamos Scientific Lab., N. Mex.), from International Atomic Energy Agency, Second Symposium on the Physics and Chemistry of Fission Processes, Vienna, July 28-August 1, 1969. 9p. (CONF-690708-7). Dep. NTIS.

The energy dependence of the penetrability of a double-humped potential barrier with a valley between the peaks is determined in the quasi-classical approximation. It is shown that the penetrability of the barrier fluctuates sharply, reaching maximum values at energies coinciding with the positions of the quasi-stationary levels in the valley. The results are used in analyzing experimental data on neutron fission. (auth)

23059 (LA-4565) ANGULAR DISTRIBUTIONS AND CORRELATIONS OF RADIATION EMITTED FROM ORIENTED NUCLEI. Steffen, R. M. (Los Alamos Scientific Lab., N. Mex.). Nov 1970. Contract W-7405-eng-36. 168p. Dep. NTIS.

An introduction is given to the general theory of angular correlation phenomena. Symmetry is stressed, and the type of information obtainable from the observation of angular correlation phenomena is pointed out. A description of the ensemble of oriented particles, angular distribution of nuclear radiation emitted from oriented nuclei, angular correlations of two successively emitted radiations, angular distribution and orientation coefficients, and angular distribution coefficients for electromagnetic radiation are discussed. Also angular distribution and orientation coefficients for conversion electrons, alpha particles, and beta particles, and extranuclear perturbations of angular distributions and correlations are treated. (J.F.P.)

23060 (LIB/Trans-333) PAIRING EFFECTS IN FISSION OF EVEN-EVEN COMPOUND NUCLEI NEAR THE THRESHOLD. Strutinskii, V. M.; Pavlinchuk, V. A. Translated for Australian Atomic Energy Commission, from pp 127-33 of IAEA Symposium on Physics and Chemistry of Fission, Salzburg, 22-26 March 1965 Vol. 1. 10p. (CONF-650301-35). Dep. NTIS (U. S. Sales Only).

An abstract of this item, prepared from the original appeared as NSA 20: 17847. (Australia)

23061 (LYCEN-7017) APPLICATION OF SOFT PION THEOREMS TO NUCLEI. Ericson, Magda (Lyon Univ. (France). Institut de Physique Nucleaire). 16 Mar 1970. 26p. (CONF-700333-1). Dep. NTIS (U. S. Sales Only).

From Conference on High Energy Physics and Nuclear Structure, Valencia, Spain.

The validity of treating nuclei as elementary particles was investigated. The soft-pion theorems, which relate processes involving the interaction of strongly interacting particles with weakly interacting particles, were used. It was found that in general the soft-pion limit could be interpreted as the Born approximation for the reaction. There are some corrections to this picture arising from the composite structure of the nucleus, but they should not exceed 5 to 10%. The deviation of the physical amplitude from the soft-pion limit is simply the distortion of the pion wave by the nucleus. It is remarkable that the nucleus can be treated as a whole and that in many cases its granular structure plays such a small role. (France)

23062 (LYCEN-7078) SU3 FRACTIONAL PARENTAGE IN THE 1-p SHELL. Meyer, J.; Nahabetian, R. S.; Joseph, J.; Lafourcriere, J. (Lyon Univ. (France). Institut de Physique Nucleaire). Nov 1970. 20p. Dep. NTIS (U. S. Sales Only).

Using the ELLIOTT SU-3 model, the fractional parentage coefficients (F.P.C.) occurring in matrix elements for various n-particle operators (n = 1,2,3, and 4) and in the reduced widths of the p shell nuclei for deuterons, tritons, and α particles, were calculated. The programs used are described. (France)

23063 (NP-18649) CALCULATION OF THE ACTIVITY PRODUCED BY IRRADIATION OF THIN TARGETS WITH HIGH-ENERGY NEUTRONS. NEURAK PROGRAM. Muenzel, H.; Schmidt, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Oct 1970. 39p. (In German). Dep. NTIS (U. S. Sales Only).

A computer program is described whereby the activities produced by the bombarding of thin targets by high-energetic neutrons may be calculated. The program requires values of the excitation function and neutron spectra. (auth)

23064 (NYO-2171-335) SELF-CONSISTENT THEORY OF NUCLEAR SPECTRA: THE PAIRING PLUS QUADRUPOLE INTERACTION MODEL APPLIED TO THE TIN ISOTOPES. Dreiss, Gerard J.; Dreizler, R. M.; Klein, Abraham (Pennsylvania Univ., Philadelphia. Dept. of Physics); Do Dang, G. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). 4 Jan 1971. 33p. Dep. NTIS.

The equations of the self-consistent core-particle coupling method, or generalized Hartree-Fock approximation, are derived for the special case of the pairing plus quadrupole-quadrupole interaction model. The bases of the approximations of this method are discussed along with the resolution of certain associated technical difficulties. Results of calculations for the tin isotopes which are completely self-consistent and satisfy all relevant physical constraints are presented. These results include the static quadrupole moments of the first 2^+ states of the even tin isotopes, energies of low-lying states of the odd tin isotopes and relative spectroscopic factors for (p,d) reactions on even targets. 16 references. (auth)

23065 (RFP-Trans-70) NUCLEAR DISINTEGRATION ENERGIES. Goldstein, L. Translated for Dow Chemical Co., Golden, Colo., from J. Phys. Radium; 8: 235-40(1937). 21p. Dep. NTIS.

It is shown that for nuclear decay, in addition to the mechanical recoil correction applied to the measured energies of emitted or absorbed particles to find the exact energy of the nuclear transformation, account must be taken of the fact that nuclei are always surrounded by a group of electrons in their atoms which is expressed by an adiabatic exchange of energy between emitted or absorbed charged particles and the atomic electrons. (J.F.P.)

23066 INFLUENCE OF THE CHEMICAL ENVIRONMENT ON ALPHA DECAY. Alder, K.; Baur, G.; Raff, U. (Univ., Basel). Phys. Lett.; 34A: 163-4(22 Feb 1971).

A possible influence of different chemical environments on α-decay is discussed. (auth)

23067 ROTATIONAL INVARIANCE IN THE CENTRIFUGAL STRETCHING OF DEFORMED NUCLEI. Trainor, L. E. H.; Gupta, Raj K. (Univ. of Toronto). Can. J. Phys.; 49: 133-43(1 Jan 1971).

An explicit model is developed for the rotational and quasi-rotational states of heavy deformed nuclei. It is assumed that the effective mass contributing to the rotational inertia lies outside a central, geometric core which is rotationally invariant. The effective mass is modified as a result of nuclear stretching which is assumed to take place against harmonic restoring forces. Good agreement with experiment is obtained for the so-called hard rotators and even for the neutron deficit and transition nuclei. Explicit expansions are obtained for the energy spectra and the effective moments of inertia in the form of asymptotic series in the angular momentum variable. These series give better convergence for low angular momenta and hard rotators. (auth) (Canada)

23068 CORE POLARIZATION AND THE NUCLEON–NUCLEUS SPIN–SPIN INTERACTION. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 34B: 37-40(18 Jan 1971).

A simple model of core polarization is used to show that the spin–spin part of the nucleon–nucleus optical potential is quenched in the same way that magnetic moments are shifted from the Schmidt single-particle values. (auth)

23069 ISOMER RATIOS FOLLOWING MULTIPLE PARTICLE EMISSION. Liggett, George Scott. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 208p. University Microfilms Order No. 70-11,325.

Thesis.

Isomer ratios following multiple-particle nuclear emissions were calculated theoretically. These calculations were performed by using the compound-nucleus statistical model. The theoretically determined values of the isomer ratios were compared to experimentally determined values. The calculations were based on the assumption that the way an excited nuclear level decays is independent of the way it was formed. To perform the calculations, the level schemes of the nuclei participating in the reaction and the particle and gamma-ray transition rates between these levels must be known. With the exception of a few discrete states at low energies, the levels of the nucleus were described as a continuum of levels. The form of the density of levels was calculated by treating the nucleus as a free Fermi gas. The particle transition rates between the levels were obtained from the absorption cross section by using the reciprocity theorem. The absorption cross sections were calculated by using the optical model. The Weisskopf estimates were used for the gamma-ray transition rates. The model introduces a number of adjustable parameters into the calculation. This study showed that only two parameters have to be varied: the spin cut-off parameter σ, which determines the spin dependence of the nuclear level density, and the percentage of quadrupole radiation in the gamma-ray cascade. Calculations of isomer ratios were performed for 26 (n,2n) reactions with incident neutron energies between 14 and 15 MeV. No conclusion could be reached about the variation of σ with the atomic mass number. Calculations were performed for 11 reactions for which the experimental isomer ratio is known for a range of energies of the incoming projectile. For most of these reactions the agreement between the theoretical and experimental results was good. These results showed that for some nuclei there is a large percentage of quadrupole radiation in the gamma ray cascade. The theoretical values of the isomer ratios were compared to values calculated using an approximate method suggested by Huizenga and Vandenbosch. A comparison of the results from the two methods showed that these approximations are questionable. The compound-nucleus statistical model successfully describes most nuclear reactions of the type studied. (TSS) (Diss. Abstr. Int., B)

23070 STATISTICAL ATTENUATION OF SHELL EFFECTS IN THE FISSION PROBABILITY OF EXCITED SUPERHEAVY NUCLEI. Moretto, L. G. (Univ., Pavia, Italy). Phys. Lett.; 34B: 191-4(15 Feb 1971).

Statistical calculations on superheavy nuclei based on the shell model and the BCS Hamiltonian are presented. The relevance of the shell-effect damping due to excitation energy on the location of the transition state and on the fission width is discussed. First-chance fission probabilities are calculated. (auth)

23071 PENETRATION OF A DOUBLE POTENTIAL BARRIER IN FISSIONING NUCLEI. Dudek, J. (Inst. for Nuclear Research, Warsaw). Phys. Lett.; 34B: 181-3(15 Feb 1971).

The transmission coefficient is calculated for a double-humped potential $V(x)$ that has finite limits for $|x|$ approaching infinity. The potential is taken with the form of two inverted, squared hyperbolic cosines joined together. (auth)

23072 SECOND ORDER EFFECTIVE CHARGES WITH REALISTIC FORCES. Ellis, P. J. (Oxford Univ.); Siegel, S. Phys. Lett.; 34B: 177-80(15 Feb 1971).

With various realistic matrix elements the second-order contributions to the effective charge are small and positive for neutrons. For protons they are small and negative, and they cancel a good part of the first order values; the cancellation among the number-conserving sets is poor. Center-of-mass effects need not be considered in evaluating effective charges or valence energies. (auth)

23073 A SECONDARY MINIMUM IN THE POTENTIAL ENERGY SURFACE OF ^{40}Ca. Meta, V. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Repnow, R.; von Brentano, P.; Dickmann, F.; Dietrich, K. Phys. Lett.; 34B: 357-60(1 Mar 1971).

Strutinsky-type calculations are extended to lighter nuclei. Secondary minima in the potential energy surface generally considered to account for the existence of fission isomers occur also in the lighter mass region. Results of ^{40}Ca are compared with experimental evidences. (auth)

23074 TWO-BODY RANDOM HAMILTONIAN AND LEVEL DENSITY. Bohigas, O.; Flores, J. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 34B: 261-3(1 Mar 1971).

It is shown numerically that strong deviations from Wigner's semi-circle law for the level probability density of a random matrix are obtained if the two-body nature of the hamiltonian is taken into account. Instead of Wigner's law the probability density approaches closely a normal (gaussian) distribution. (auth)

23075 ASYMMETRY IN NUCLEAR FISSION. Pauli, H. C.; Ledergerber, T.; Brack, M. (Univ., Basel). Phys. Lett.; 34B: 264-8(1 Mar 1971).

The deformation energies for fissioning nuclei in the actinide region are calculated using the Strutinsky shell-correction method. Instability of the second barriers against an asymmetric shape degree of freedom is found in agreement with Möller and Nilsson. The inclusion of these asymmetric deformations improves the agreement between calculated and experimental barrier heights. The asymmetries found have the correct magnitude in order to explain the experimental mass ratios of the fission fragments. (auth)

23076 SECOND CLASS CURRENTS AND MESON EXCHANGE EFFECT IN NUCLEAR BETA DECAY. Delorme, J. (Institut de Physique Nucleaire, Lyon); Rho, M. Phys. Lett.; 34B: 238-42 (1 Mar 1971).

It is pointed out that two forms of the induced pseudotensor current, equivalent on the mass shell, lead to quite different results in nuclei for $\delta = (ft)_{\beta+}/(ft)_{\beta-} - 1$ which was used by Wilkinson as evidences for a possible presence of the second class current, and therefore to an ambiguity in determining the coupling constant g_T. It is shown that the resolution of this ambiguity requires a consideration of meson-exchange current. The two-body current thus appearing is found to give in fact a dominant contribution to δ. (auth)

23077 TWO-CENTER SHELL MODEL. Scharnweber, Dieter (Univ., Frankfurt am Main); Greiner, Walter; Mosel, Ulrich. Nucl. Phys.; A164: 257-78(1971).

The two-center shell model is summarized: spin-orbit and l^2 terms are included in the double-center oscillator. Various conditions for volume conservation during the deformation process are studied. The shell structure for symmetric break-up is established and potential energy surfaces for nuclear fission are calculated. (auth)

23078 COUPLED CHANNELS CALCULATIONS WITH COMPLEX EIGENVALUES. II. Lejeune, A.; Nagarajan, M. A. (Univ., Liege). Nucl. Phys.; A164: 246-56(1971).

A soluble coupled square-well model is analysed by the use of Kapur–Peierls dispersion theory. The dependence of the complex eigenvalue on the channel radii is studied and a unitarized one-level approximation to the S-matrix theory is suggested. It is shown that the lack of unitarity is confined only to the elastic scattering channel. A comparison between the predicted and exact inelastic scattering cross section is made with a model with three coupled square wells. (auth)

23079 THEORETICAL FOUNDATION OF VARIABLE MOMENT OF INERTIA MODELS. Das, T. K.; Dreizler, R. M.; Klein, A. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 34B: 235-7(1 Mar 1971).

A derivation of the VMI model is presented which is general enough to account for its successful application to both deformed and spherical nuclei. A derivation of multiband generalizations is also outlined. (auth)

23080 CALCULATION OF COULOMB DISPLACEMENT ENERGIES IN LIGHT NUCLEI. de Meijer, R. J.; van Royen, H. F. J.;

Brussaard, P. J. (Rijksuniversiteit, Utrecht). Nucl. Phys.; A164: 11-33(1971).

Coulomb displacement energies are calculated in terms of first-order perturbation theory and the results are compared with the experimental data. In the model the Coulomb displacement energy is described as a sum of single-particle Coulomb displacement energies, which result from changing a neutron outside a core into a proton with the same quantum numbers. In the calculations only two parameters were used, which were kept constant for A = 13–28 and A = 29–40. From a comparison between theoretical and experimental Coulomb displacement energies one finds that for about 70% of all levels the deviation between the theoretical and experimental energies is smaller than 64 keV. A relatively large deviation of 200 keV is found for the lowest $J^{\pi} = 0^{+}$, T = 1 states in doubly odd self-conjugated nuclei. (auth)

23081 FINITE-RANGE CORRECTIONS IN TWO-NUCLEON TRANSFER REACTIONS. Rost, E.; Kunz, P. D. (Univ. of Colorado, Boulder). Nucl. Phys.; A162: 376-84(1971).

A method is developed for calculating finite-range corrections in two-nucleon transfer reactions which is readily adapted to current distorted-wave Born approximation calculations. Finite well wave functions are used and terms up to second order in the range are carried. The method is tested for the $^{46}Ti(p,t)^{46}Ti$ reaction at 27 MeV where the DWBA calculations are known to be very sensitive to parameter variations. Although the second-order terms are appreciable the method does appear to be converging. (auth)

23082 THREE-BODY BINDING ENERGY FOR POTENTIALS WITH HARD CORE. Badalyan, A. M.; Gal'pern, E. S.; Lyakhovitskii, V. N.; Simonov, Yu. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 221-31(Jan 1971). (In Russian).

A previous method treating the small-range repulsion as a perturbation, is applied to the three-nucleon system interacting through realistic potentials with a hard core. The K-harmonics method is used for the zero approximation. Square-well potentials with a hard core in various spin-isospin states, fitted to the data on the s-wave scattering up to 320 MeV, are chosen as examples for the calculations. Rapid convergence of the perturbation series in the separation radius is shown; and for the ^{3}H a value of binding energy E = −8.23 MeV is obtained in the first order; this fact indicates a weak dependence of the energy on the introduction of a core for a given potential. Another variant of the perturbation theory, the series in the pure core radius, provides a near value of the energy. (auth)

23083 PHOTODISINTEGRATION OF HELIUM. Yadav, H. L.; Mahanti, D.; Srivastava, B. K. (Indian Inst. of Tech., Kharagpur). J. Phys., A (London): 4: 49-54(Jan 1971).

The integrated and the bremsstrahlung-weighted cross sections in the photodisintegration of ^{4}He are calculated by applying the sum rules of Levinger and Bethe and using the velocity-dependent potential of Nestor et al. (NSA 22: 32718). The wave function used is a mixture of the $^{1}S_0$ and the principal $^{5}D_0$ states, the radial dependence of both these states being Gaussian. The parameters of the wave function are obtained from a variational calculation of the binding energy. The results show good agreement with experiments and with similar calculations using hard-core potentials. (auth) (UK)

23084 BINDING ENERGY OF THE ALPHA PARTICLE WITH A VELOCITY-DEPENDENT POTENTIAL CONTAINING A TENSOR COMPONENT. Mahanti, D.; Yadav, H. L.; Srivastava, B. K. (Indian Inst. of Tech., Kharagpur). J. Phys., A (London); 4: 44-8(Jan 1971).

A variational calculation is made of the binding energy of the alpha particle with the velocity-dependent potential of Nestor et al. (NSA 22: 32718) which contains a tensor component. The trial wave function used is a mixture of the $^{1}S_0$ and the principal $^{5}D_0$ states, the radial dependence of both these states being Gaussian. The Coulomb energy of interaction is calculated by the usual perturbation method with the potential of Schneider and Thaler which takes into consideration the finite size of the nucleons. The values of the binding energy and the root-mean-square radius of the alpha particle calculated are in reasonably good agreement with experiments. (auth) (UK)

23085 ANALYTICAL DETERMINATION OF THE MOESSBAUER QUADRUPOLE HYPERFINE PARAMETERS FOR HALF-INTEGRAL NUCLEAR SPINS. Williams, P. G. L.; Bancroft, G. M. (Cambridge Univ., Eng.). Mol. Phys.; 19: 717-20(Nov 1970).

A Hamiltonian is given representing the interaction of a nucleus having spin I and quadrupole moment eQ with an electric field gradient specified by eq and η. Equations arising from the expression are solved for values of I between $\frac{3}{2}$ and $\frac{9}{2}$. The equations are used together with values of E_t for an observed spectrum to obtain values for e^2qQ and η. (UK)

23086 NUCLEAR STRUCTURE EFFECTS IN THE MAGNETIC HYPERFINE INTERACTION. Johnson, John Alan. Pittsburgh; Carnegie-Mellon Univ. (1970). 91p. University Microfilms Order No. 70-7332.

Thesis.

Nuclear magnetic moments, muon magnetic hyperfine structure, and the hyperfine anomaly are investigated using the pairing interaction and the pairing-plus-quadrupole model in medium and heavy spherical nuclei. The pairing calculations include three-quasi-particle corrections due to a delta force interaction between quasi-particles or between particles in the component of the BCS wavefunction with the correct number of particles. The quasi-particle moments are taken to be those corrected by the delta function interaction in the pairing plus quadrupole model. The magnetic moments are well predicted by the models if it is assumed that meson effects are less than 0.3 nuclear magnetons. There is not enough experimental data to distinguish the models in muonic hyperfine structure, but the predictions are fair to good in the few measured cases. Much more experimental data exists for the hyperfine anomaly but uncertainties in the electron wavefunctions preclude judging among the models. A method is presented for correcting the calculations for electron shielding and configuration mixing and thus providing a test of electron wave functions. (Diss. Abstr. Int., B)

23087 CRITICAL RE-EVALUATION OF NUCLEAR SHELL MODELS IN THE MASS-14 SYSTEM. Laird, Christopher Eli. University, Ala.; Univ. of Alabama (1970). 71p. University Microfilms Order No. 71-1250.

Thesis.

Nuclear theorists have developed a number of models to describe the structure of nuclei. These theorists make certain assumptions concerning the nature of nuclear forces and proceed to calculate eigenvalues and eigenvectors for various nuclei and their excited states. These eigenvectors are used to calculate various nuclear properties which, along with the eigenvalues, are compared with the results of experiment to determine which models or model are appropriate for these nuclei. When studied in the manner outlined above, the mass-14 system has been the subject of considerable controversy. This system is the only one in the p-shell in which a tensor force has been required to adequately explain its properties. In order to re-evaluate the necessity of a tensor force, the system is re-examined from two points of view. First, a set of configuration mixing parameters are obtained from a series of simultaneous equations formed by equating theoretical expressions for various properties with their respective experimental values. Second, these parameters are used along with those from other models to calculate the beta-decay spectrum of ^{14}O. By comparison with experimental data, the models which most adequately describe the system are determined. In order to determine the shape of the beta-decay spectrum as accurately as possible, the theoretical expression is recalculated retaining some terms usually in conventional expressions. The electron radial functions used in this calculation are of an analytic nature obtained by a solution to the Dirac equation with an electrostatic potential appropriate for a uniformly-charged nucleus. The nuclear matrix elements used reflect several recent corrections to the conventional expressions. The results of this investigation indicate that those nuclear models containing tensor forces most adequately describe the properties of the system, with the possible exception of the so called "empirical model." (Diss. Abstr. Int., B)

23088 EQUIVALENCE OF LOCAL AND NON-LOCAL POTENTIALS AND THE PEREY EFFECT. de Forest, Taber Jr. (Ecole Normale Superieure, Orsay, France). Nucl. Phys.; A163: 237-48(1971).

A general discussion of the transformation which relates the wave functions in equivalent non-local and energy dependent local potentials is presented. In general this relation is nonlocal, $\psi_{nl} = \hat{P}\psi_L$, however it is shown that $\hat{P}$ must contain a local part $P_0 = (1 - \partial V_L(E)/\partial E)^{\frac{1}{2}}$. For reasonable potentials P_0 is expected to be the most important contribution to $\hat{P}$. This is also shown explicitly by generating by means of an expansion an equivalent non-local potential from a given local potential. If the non-local potential is assumed to have the form $V_{nl}(|r-r'|, |r+r'|)$ this allows one to determine P (beyond the first approximation, $\hat{P} \approx P_0$) and thus obtain ψ_{nl} directly from the wave functions used in the usual optical-model analysis of the scattering. Finally this expansion when applied in reverse provides an extension of the effective mass approximation. (auth)

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23089 COEFFICIENTS OF FRACTIONAL PARENTAGE OF MANY-BOSON SYSTEMS. Kishimoto, Teruo; Tamura, Taro (Univ. of Texas, Austin). Nucl. Phys.; A163: 100-12(1971).

A very compact way is presented to calculate coefficients of fractional parentage (cfp), needed in constructing wave functions for states belonging to a large number of quadrupole phonons. Examples are also given of the use of thus constructed cfp in evaluating matrix elements of some operators of the form of products of phonon creation and annihilation operators. (auth)

23090 PERTURBATION THEORY OF A MANY-FERMION SYSTEM. I. SINGLE-PARTICLE ENERGIES AND THE FACTORIZATION PROBLEM. Jones, Robert W. (Univ. of South Dakota, Vermillion); Mohling, Franz. Nucl. Phys.; A151: 420-48(1970).

Methods are developed in the time-dependent perturbation theory of a ground state, many-fermion system for the study of the self-energy and factorization problems. The diagrammatic, time-dependent perturbation series is rearranged so that all the self-energy structures are contained in a single function which has the role of a line-weighting factor. These line-weighting factors are related to the single-particle occupation probabilities and are determined by the choice of the model single-particle potential. A systematic procedure is developed for choosing a model single-particle potential which satisfies the principle of maximal cancellation of perturbation diagrams. The model single-particle energies resulting from this choice of the model single-particle potential are shown to satisfy Landau's theory of a normal fermi liquid. This choice is compared with, and is found to differ from, the usual choice based on the "generalized-time-ordering procedure" in the time-independent Goldstone series. (auth)

23091 INFLUENCE OF SHELL STRUCTURE AND PAIRING INTERACTION ON NUCLEAR LEVEL DENSITIES. Lang, Hermann (Univ., Giessen, Ger.). Z. Phys.; 242: 179-88(1971). (In German).

The density of nuclear single particle states is calculated within the framework of the spherical oscillator model including spin orbit and pairing interactions. The use of the oscillator energies leads to a strong influence of shell-effects on the level density which are slightly reduced, if pairing interactions are taken into account. (auth)

23092 NUCLEAR MASSES, SHELL-MODEL, AND SUPER-HEAVY NUCLEI. I. Koehler, H. S. (Univ. of Arizona, Tucson). Nucl. Phys.; A162: 385-406(1971).

Self-consistent field calculations in some closed shell nuclei are presented. A four-parameter, quadratically velocity-dependent central interaction is used. The parameters are initially adjusted to reproduce mass-formula parameters of Myers and Swiatecki. A spin-orbit field is added and is chosen to be 30 times the Thomas form. A somewhat better fit to binding energies is obtained by a slight adjustment of the surface energy from 18.56 to 19.0 MeV and of the symmetry energy from 28.0 to 32.5 MeV. The spin-orbit strength, when adjusted to fit ^{48}Ca binding energy, is reduced to 27.5. This two-body effective interaction reproduces binding energies reasonably well, but it does not reproduce single-particle energies well (defined as removal energies). The level density is too small, the gaps at closed shells are roughly twice as large as they should be, and states of larger angular momentum are consistently too strongly bound compared to those of smaller angular momentum. The addition of a density-dependent repulsion of short range, to simulate core repulsions in the two-body interaction, improves the single-particle spectrum somewhat. Both interactions give a closed proton shell in ^{298}114 at Z = 114 due to a $f_{\frac{1}{2}} - f_{\frac{5}{2}}$ splitting of 3 MeV. The N = 184 gap due to the $s_{\frac{1}{2}} - j_{15/2}$ distance is found to be only 1.5 MeV. However, in ^{312}114 the N = 198 gap is found to be 4.1 MeV due to the $j_{15/2} - h_{11/2}$ distance. The calculated level structure for these superheavy nuclei is found to be more sensitive to the two-body interactions than is that for the lighter nuclei. The gaps at ^{298}114 and ^{312}114 may therefore be different for a more realistic interaction. The binding energy of the semi-infinite system is also calculated self-consistently, allowing a determination of the surface energy. Comparisons between the liquid drop and the shell-model total binding energies can therefore be made which show that the correction to the former model is several percent. The definition of single-particle energies is discussed at some length. (auth)

23093 COULOMB ENERGY DIFFERENCES OF MIRROR NUCLEI IN THE sd SHELL. Cillie, G. G.; Van der Merwe, J. H. (Univ. of Stellenbosch, S. Afr.). Nucl. Phys.; A162: 417-22 (1971).

The Carlson–Talmi shell-model theory for Coulomb energies of mirror nuclei indicates an appreciable discontinuity of the harmonic oscillator parameter $e^2(\nu/\pi)^{\frac{1}{2}}$ and the nuclear radius parameter r_0 at A = 29. To be more realistic, configuration mixing within the sd shell at least should be taken into account. Considerations of a qualitative nature suffice to show that thereby the discontinuity loses its significance. (auth)

23094 MODIFIED-FANO AND K-MATRIX APPROACHES TO THE RESONANT NUCLEAR REACTIONS. Bledsoe, H.; Tamura, T. (Univ. of Texas, Austin). Nucl. Phys.; A164: 191-208(1971).

Reformulation is made of the general Fano approach to allow a non-orthogonal basis to be taken as a starting point. The K-matrix approach is also reformulated so that expressions for the S-matrix and other related quantities are given very compactly, even when there are continuum-continuum interactions. Applying these formulas, some numerical calculations are made for isobaric analog resonances. (auth)

23095 VIRTUAL PHOTON CROSS SECTIONS FOR TWO-BODY ELECTRODISINTEGRATION. Gibson, B. F.; Williams, H. T. (National Bureau of Standards, Washington, D. C.). Nucl. Phys.; A163: 193-202(1971).

Two-body electrodisintegration cross sections (differential with respect to the angles of the ejected nuclear fragment) are developed in the long wavelength limit of virtual photon theory for the few-nucleon system. Only the non-spin-flip electric transitions are considered. Contributions from the multipole expansion through the E1–E3 interference terms are retained. Comparable photodisintegration expressions are included to facilitate the extraction of photo cross sections from appropriate inelastic electron scattering data. (auth)

23096 STUDY OF THE SPIN–ORBIT SPLITTING IN NUCLEI NEAR CLOSED SHELLS. Scheerbaum, Robert R. Ithaca, N. Y.; Cornell Univ. (1969). 268p. University Microfilms Order No. 70-8677.

Thesis.

The spin-orbit component of the shell model potential arising from the effective two-nucleon spin-orbit force is derived in the Hartree–Fock approximation. The derivation applies to the interaction of a nucleon with a spin-saturated core of nucleons. The method employed makes use of the extreme short range character of the two-nucleon force to obtain an expansion of the one-body potential in powers of the relative coordinate. This is an extension of a method first introduced by Blin–Stoyle. This shell model potential is then used to calculate the contributions, from their spin-saturated cores, to the spin-orbit splitting of various levels in nuclei near closed shells. The splittings are calculated for three different nuclear models: a) the spherical harmonic oscillator shell model, b) using a Fermi distribution to describe the nucleons in the spin-saturated core and pure harmonic oscillator wave functions to describe the outer nucleon, and c) using the results of a realistic Brueckner–Hartree–Fock calculation to describe all the nucleons. Significant differences between these models (b) and (c) being definitely superior to model (a), especially for the heavier nuclei. In general the contribution from the spin-saturated core is found to be too small to give agreement with experiment, although isolated levels are found which do agree well with experiment. The splittings are found to be somewhat dependent on the free-space nucleon-nucleon potential which is used to construct the effective two-nucleon spin-orbit force. The effect of the higher moment terms in the expansion is discussed and arguments are presented as to the theoretical validity of the expansion in the range of the two-body interaction. The calculated results are generally thirty percent to fifty percent smaller than the experimental splittings, indicating that some other mechanism(s) must also contribute to the spin-orbit effect. (Diss. Abstr. Int., B)

23097 BINDING ENERGIES OF LIGHT NUCLEI. Hare, M. B.; Papini, G. (Univ. of Saskatchewan, Regina). Lett. Nuovo Cim.; 4: 1023-6(28 Nov 1970).

A procedure for determining the binding energies of light nuclei is outlined. The close analogy between electric charge and mass as quantities respectively indicating the source strength of the electromagnetic and gravitational fields is used to obtain dispersion relations for the mass-energy form factors of light nuclei and nucleons. The binding energies can then be expressed as sum rules over the imaginary parts of the appropriate mass-energy form factors. (J.W.R.)

23098 MODEL FOR THE PRODUCTION OF (p,n) AND (p,2n) REACTIONS AT HIGH ENERGY. Reuland, D. J. (Indiana State Univ., Terre Haute); Caretto, A. A. Jr. Nucl. Phys.; A151: 449-58(1970).

The ratios of the cross sections for the (p,2n) reaction to that of the (p,n) reaction at 400 MeV were calculated for a variety of tar-

get systems from a theoretical model and compared with the experimental ratios. The assumed mechanisms were a p-n scattering followed by evaporation of one neutron for the (p,2n) reaction and a p-n scattering with no subsequent evaporation of particles for the (p,n) reaction. The large variations of the $\sigma(p,2n)/\sigma(p,n)$ ratio within small mass regions experimentally observed are well represented by this calculation. For target systems where the isobaric analog states lie above the separation energies of the least bound neutrons of the p-n products, the magnitudes of these ratios as well as their variations with mass number are predicted reasonably well. For target systems where the isobaric analog states lie below the separation energies of the least bound neutrons, the variations of the cross-section ratios with mass number are again accounted for; however the magnitudes of the ratios are high by factors of 2 to 4. This could indicate that enhanced population of the isobaric analog state in the p-n scattering event does indeed enhance the (p,n) cross section for these systems and thereby reduce the $\sigma(p,2n)/\sigma(p,n)$ ratio considerably. (auth)

23099 MANY-BODY THEORY OF NUCLEAR SPECTRAL RELATIONS. West, Bruce Joseph. Rochester, N. Y.; Univ. of Rochester (1970). 247p. University Microfilms Order No. 71-1435.

Thesis.

A theory of the relations between the particle-particle (pp), particle-hole (ph) and hole-hole (hh) nuclear spectra is developed using the effective interaction of the Brueckner–Goldstone many-body theory. The theory constructed explains the experimental violations of the Shell Model spectral relations as being due to many-body effects in the nuclei considered. The Shell Model relation of Pandya, Goldstein and Talmi is shown to be an approximation of a more general many-particle relation, as are the other nuclear spectral relations. The theory divides the effective interaction (ν) between the valence particles into two parts, i.e., $\gamma = \gamma_c + \gamma_v$. The first part of the interaction (ν_c) conserves the Shell Model spectral relations, the second part (ν_v) does not. The contributions to (ν_v) are calculated using both perturbation theory and matrices for the three nuclei ^{42}Sc(pp), ^{48}Sc(ph) and ^{54}Co(hh). The new theory applied to the Triptych of nuclei above gives considerably better agreement with experiment than do the standard Shell Model relations. For example, the root mean square deviation between the predicted and experimental levels of ^{42}Sc and 690 keV and 805 keV using the standard Shell Model relations along with ^{48}Sc and ^{54}Co respectively. This is to be compared with 335 keV and 520 keV for the root mean square deviation using the new theory. (Diss. Abstr. Int., B)

23100 INFLUENCE OF THE RADIAL DISTRIBUTION OF NUCLEAR CHARGE ON ASYMMETRY IN FISSION. Nair, R. Kesavan. Gainesville, Fla.; Univ. of Florida (1970). 149p. University Microfilms Order No. 71-266.

Thesis.

The potential energy of ^{236}U compound nucleus as a function of deformation is studied based on the liquid drop theory, including the effects of re-distribution of nucleons and charge caused by the nuclear compressibility and the electrostatic potential. Minimization of the total energy yields three partial differential equations for the neutron and proton densities and the electrostatic potential in the nucleus. The nucleon and charge distributions are determined by solving these equations by a variational method. The effect of a diffuse surface is also included. Changes in the volume energy (due to nuclear forces), the surface energy and the Coulomb energy caused by nuclear deformation are computed using the nucleon and charge distributions determined. The deformed nucleus is represented by two unequal spheres connected by a conicoid. Within the range of shapes studied, the asymmetric configurations have been found to have lower energies than the symmetric ones, indicating that a heavy nucleus in the neighborhood of uranium might favor an asymmetric shape at the transition state en route to fission. The results obtained also suggest that the nucleon configuration of the final fragments from fission may be partially determined at as early a stage as the saddle point. These observations are contrary to the results from the studies based on the idealized liquid drop theory in which nucleon and charge distributions are assumed to be uniform within the nucleus. (Diss. Abstr. Int., B)

23101 THEORETICAL ANALYSIS OF NUCLEAR REACTIONS INVOLVING STRONGLY DEFORMED NUCLEI USING PHENOMENOLOGICAL MODELS. Mackintosh, Raymond Stuart. Berkeley, Calif.; Univ. of California (1970). 266p. University Microfilms Order No. 71-808.

Thesis.

Stripping reactions, A(d,p) A + 1, are studied for the case where A is a strongly deformed nucleus. In the standard treatment, using DWBA, the possibility that the projectiles d and p can set the nucleus in rotational motion is ignored. The importance of these inelastic processes is studied using the coupled channel source-term technique of Ascuitto and Glendenning. This is shown to be equivalent to the coupled channel Born Approximation written down by Penny and Satchler. A formal derivation of DWBA given by Greider and Dodd is generalized. For A ~ 25 and for 10- and 12-MeV deuterons, inelastic processes are of vital importance — that relative strengths of levels may be greatly changed by their inclusion and that angular distributions may be significantly improved, although the detailed shape is still not reproduced for these light nuclei. This latter failing, therefore, seems to be characteristic of any generalization for zero range DWBA to include rotational excitations. For 12-MeV deuterons in the deformed rare earth region, the inclusion of inelastic processes will, in general, lead to substantial differences in values, extracted by comparison with experiment, of the amplitudes with which particular angular momenta occur in the various Nilsson states. Angular distributions of weaker levels in a band are often changed substantially and the change in stripping strengths of various levels is quite comparable to that which is a result of coriolis mixing (not included in the calculations). The calculations involve purely macroscopic rotational excitations and ignore transitions between members of different bands of the odd A residual nucleus. (Diss. Abstr. Int., B)

23102 MODIFIED MODEL OF COMPLEX MOMENTA AND ITS APPLICATION TO RESONANCE NUCLEAR REACTIONS. Grushin, V. V.; Nikitin, Yu. P. Yadern. Fiz.; 13: 156-63(Jan 1971). (In Russian).

The elastic scattering amplitude of particles with spins 0 and $\frac{1}{2}$ on nuclei in the resonance energy region is presented as a sum of the pole terms in the complex momentum plane λ. The pole amplitudes obtained are unitary, have Regge asymptotics, the correct position of the branching point in the t plane. The integral contribution along the imaginary axis turns out to be negligibly small. The expressions obtained make it possible to calculate differential cross section and angular dependence of polarization of scattered particles in the region of resonance energies. Unknown parameters are the positions of poles. The parity of excited levels of the ^{13}C nucleus with excitation energy 8.8 MeV and spin $\frac{1}{2}$ is determined by means of the formula obtained on the basis of the measured neutron polarization in reaction ^{12}C(n,n)^{12}C at the neutron energy of 4.4 MeV. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 21289, 21292, 21299, 21309, and 23232.

23103 (BMBW-FBK-70-23) DEVELOPMENT PROGRAM: LINGEN NUCLEAR POWER STATION. Final Report. Rehn, H. (ed.) (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Grosswelzheim (West Germany)). Nov 1970. 271p. (In German). Dep. NTIS (U. S. Sales Only).

As part of a government subsidized research and development program the necessary provisions for construction and start-up of the Lingen plant were produced between 1964 and 1968. The following requirements had to be fulfilled: (a) forced coolant circulation; (b) power distribution as even as possible; and (c) good controllability. The development of cyclone-type steam separators was the result of (a). For (b) the calculation data were produced and in-core detectors for the neutron flux developed. Control (c) was secured by means of continuously adjustable control rods and, for the first time, by coolant flow control. 48 references. (auth)

23104 (GA-10196) EXAMINATION OF PEACH BOTTOM HTGR CONTROL ROD, CONTROL ROD GUIDE TUBE, AND THERMALLY RELEASED SHUTDOWN ROD CO8-01 AFTER 300 EFFECTIVE FULL POWER DAYS OF OPERATION. Stansfield, O. M. (Gulf General Atomic Co., San Diego, Calif.). Dec 1970. Contract AT(04-3)-314. 74p. Dep. NTIS.

The control rod and control rod guide tube from position CO8-01 of the Peach Bottom High-Temperature Gas-Cooled Reactor were examined after 300 effective full power days of operation. The general condition of the control rod was essentially unchanged from the manufactured condition except for a discoloration of metallic parts, some embrittlement of Haynes 25 alloy disk springs, and axial shrinkage of the boronated graphite neutron absorbers. The maximum absorber shrinkage observed was about 0.28% in an absorber that had been positioned at the middle of the core and had received a fast neutron exposure of about 1.2×10^{21} n/cm^2 (E > 0.18 MeV). The irradiation-induced axial shrinkage as a function of fast neutron exposure was in agreement with irradiation data from similar material at higher exposure. Changes in diametral dimensions were not great enough to exceed manufactured tolerances. On the basis of an analytical model of the absorber, the stresses and strains in the absorber walls were calculated. Satisfactory performance was predicted to full lifetime exposure. The guide tube showed few effects of the reactor exposure. Spots were observed at the point of contact with fuel elements, but no wear was observed there. The major deviations from the manufactured condition were a cracked thermally released shutdown absorber support and an axial bow of about 0.122 in. in the guide tube bow suggested an accelerated shrinkage on the surface facing the core outside diameter, which is consistent with the higher fast neutron exposure expected on that side. Restraint in the core, creep in the graphite, and a more constant rate of irradiation-induced dimensional change beyond 300 EFPD will tend to minimize stress and additional bow so that significant additional guide tube bow is not expected. The release temperature of the thermally released shutdown rod was measured and found to be 1740 ± 5°F and apparently unchanged by the reactor exposure. 17 references. (auth)

23105 (ORNL-HUD-13) THERMAL EFFECTS OF VARIOUS AIR-CONDITIONING METHODS USED IN CONJUNCTION WITH AN ELECTRIC POWER PRODUCTION AND DISTRICT HEATING FACILITY. Lackey, M. E. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 42p. Dep. NTIS.

The thermal energy requirements for air conditioning by both compression and absorption methods were determined for three steam cycles during a study of the possibilities for using heat produced by plants generating electricity. The three cycles are those of the large fossil-fueled plants (FFP), advanced reactors (AR) under development (such as the liquid-metal fast breeder, advanced gas-cooled reactors, and the molten-salt thermal breeder), and the light-water reactors (LWR) presently in operation. The first generation of the liquid-metal-cooled fast breeder (F-LMFBR) is now under development. With the exception of stack losses, the results obtained for these reactor types are directly applicable to fossil-fired plants with comparable steam cycles. Calculations were made of the additional plant energy needed to produce a ton-hr of refrigeration by various methods without reducing the plant's initial production of electricity The requirements for vapor compression systems varied from 5600 Btu for a turbine-driven compressor system used with the FFP and AR to 8800 Btu for an electric-motor-driven compressor system used with a LWR steam cycle. The requirements for producing a ton-hr of refrigeration by heat absorption varied from 5700 Btu for a system supplied with 2-psig back-pressure steam from the F-LMFBR to 12,700 Btu for a system supplied with 380°F water heated in stages with steam extracted from a light-water reactor. The energy disposal at the reactor site resulting from the production of a ton-hr of refrigeration varies with the type and location of the refrigeration system. An absorption system located at the reactor site supplied with 380°F from a light-water reactor would cause an increase in the reactor site energy disposal of 24,700 Btu, which includes the 12,000 Btu removed from the consumption site by a ton-hr of refrigeration. In comparison, an absorption system producing a ton-hr of refrigeration at a site remote from the reactor site and supplied with 2-psig steam from the F-LMFBR would result in a decrease of 11,500 Btu in the reactor site energy disposal. The major effect of air conditioning with heat is to ease the thermal pollution problem by moving much of the heat normally released at the generating plant site to many scattered air-conditioning sites. 4 references. (auth)

23106 (UJV-2346.R,F.) CRITICALITY CALCULATION OF THE A-1 REACTOR USING THE HETEROGENEOUS METHOD. Miasnikov, A.; Rocek, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Mar 1970. 33p. (In Czech). NTIS (U. S. Sales Only).

Critical heights of a cold non-poisoned A-1 reactor with various core fillings were computed using the HECATE 1 program based on the heterogeneous method. The results are presented in tables and graphs. The program is very sensitive to the accuracy of some of the input data; e.g., for the ^{235}U percentage in natural uranium ranging from 0.705 to 0.725%, or for the number of fission neutrons per fission, ν, ranging from 2.43 to 2.47, the differences in the computed critical heights amount up to tens of centimeters. (INIS)

23107 (UJV-2382.R.) XENON STABILITY OF THE A-2 REACTOR. Data for the Selection of an Optimum A-2 Reactor Control System. Blazek, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1970. 5p. (In Czech). NTIS (U. S. Sales Only).

Results of xenon stability computations are given in tables and graphs for a variant of the heavy-water A-2 reactor which was selected as optimum at the Institute of Nuclear Research and which forms the basis for a project of this reactor. Physical parameters of the reactor, needed in the computations, are tabulated. Fuel loading and the temperature coefficient were varied in the stability computations. The first Lyapunov method was employed to decide on the reactor stability. (auth)

23108 NUCLEAR POWER IN THE SOUTH. A Report of the Southern Governors' Task Force for Nuclear Power Policy, Presented at the 1970 Southern Governors' Conference, September 22, 1970. Atlanta; Southern Interstate Nuclear Board (1970). 138p. $5.00. (NP-18713).

Information on the public issues, opportunities, and environmental effects related to the increased use of nuclear power in 17 Southern states is reported. Recommendations are offered on nuclear power policies for consideration by the state Governors. Major topics discussed include: power requirements; developmental planning; nuclear industry; nuclear safety; public health; environmental effects; and laws and regulations. 172 references. (H.D.R.)

23109 UNIT NO. 3 OF FUKUSHIMA NUCLEAR POWER STATION, TOKYO ELECTRIC POWER CO. Asihara, Eturo; Kani, Ziro; Ogawa, Nagao; Itoh, Mutsumi (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Toshiba Rebyu; 25: 1553-8(Dec 1970). (In Japanese).

The unit No. 3 of the Fukushima Nuclear Power Station of the Tokyo Electric Power Co., with the same electrical output as the unit No. 2, 783,913 kW, is described. (auth)

23110 INDUSTRIAL ENERGY RESOURCES. Hubbert, M. King (Geological Survey, Washington, D. C.). pp 179-206 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Predicted power requirements in the U.S. are described. Fossil fuel and nuclear power resources are reviewed. 14 references. (D.C.C.)

23111 NORTHWEST CONFERENCE ON THE ROLE OF NUCLEAR ENERGY. Second Annual Governor's Conference on Conservation, Portland, Oregon, December 4–5, 1969. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970). 215p. (CONF-691223).

The development of nuclear power plants in Northwest U. S. is discussed. Separate abstracts are included for 16 of the 17 papers presented. One paper discussed the role of fossil fuels in power generation. (D.C.C.)

For abstracts of individual papers see: 23112–23117, 23139, 23140, and 23218–23225.

23112 ENERGY REQUIREMENTS AND HYDROPOWER GENERATION IN THE NORTHWEST. Richmond, Henry R. (Bonneville Power Administration, Portland, Oreg.). pp 7-17 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

Actual and forecast power requirements for the Northwest region of the U. S. are presented for 1950 to 1990. The use of hydroelectric, fossil fuel, and nuclear power plants to meet power requirements is discussed. (D.C.C.)

23113 20545. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). pp 43-53 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

The energy requirements for the U. S. are described. The ability of fossil fuel and nuclear power plants to meet the energy requirements is analyzed. Safety standards regulating nuclear power plants and the relationship between nuclear power plants and the environment are discussed. AEC responsibilities to the public and to electric utilities are reviewed. (D.C.C.)

23114 NUCLEAR INDUSTRY: PRESENT STATUS AND PROSPECTS. Tremmel, Ernest B. (Atomic Energy Commission, Washington, D. C.). pp 62 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

Developments in the nuclear industry during 1969 are reviewed. Projected growth of nuclear power plants to 1980 is presented. (D.C.C.)

23115 UTILIZATION OF NUCLEAR ENERGY FOR POWER GENERATION: PRESENT STATUS AND PROSPECTIVES. Bupp, Lamar P. (Oregon State Univ., Corvallis). pp 63-70 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

A fundamental explanation of how nuclear energy is used to generate electrical power is presented. Present nuclear power systems are compared with anticipated future applications of nuclear heat to generate electricity by other means. (D.C.C.)

23116 IMPACT OF NUCLEAR POWER ON NUCLEAR INDUSTRY. Albaugh, F. W. (Battelle-Northwest, Richland, Wash.). pp 85-93 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

The developments of fast breeder reactors and plutonium recycle in water cooled power reactors are predicted. Quality assurance programs for nuclear power plants are described. 4 references. (D.C.C.)

23117 NUCLEAR ENERGY DEVELOPMENTS IN THE PACIFIC NORTHWEST. Itschner, Emerson C. (Portland General Electric Co., Oreg.). pp 94-102 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

23118 OXIDATION BEHAVIOR OF STEEL IN CO_2-COOLED REACTORS. Gemmill, M. G. (Central Electricity Generating Board, London). Atomwirt., Atomtech.; 16: 42-3(Jan 1971). (In German).

Oxidation caused no significant impairment of large sized components in the natural uranium Magnox reactors. Some bolts, however, ruptured because of oxidation of mild steel washers. After experimental studies and thorough analysis, the probability of such damage was reduced by changing operational conditions. Problems encountered by the Magnox reactors led to a quantitative analysis of boundary layer oxidation in advanced gas-cooled reactors. Based on this analysis, a selection could be made of materials that were resistant to oxidation. Moreover, a structural design could be made which reduced impairment by oxidation to a minimum. 8 references. (tr-auth)

23119 ELECTRIC ENERGY TRENDS IN THE U. K. Adamson, Colin (Polytechnic of Central London). Power Eng.; 75: No. 2, 26-32(Feb 1971).

23120 ASEISMIC DESIGN IN THE TSURUGA NUCLEAR POWER PLANT. I. ASEISMIC DESIGN PRINCIPLES. Akino, Kinju; Kato, Muneaki; Tamura, Seiya (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi; 13: 14-22(Jan 1971). (In Japanese).

The Tsuruga Nuclear Power Plant is of boiling water type. The purpose of aseismic design is to protect the inhabitants in the plant environment and the operators of the plant from radiation hazard in the event of an earthquake. Another aim in aseismic design is to provide adequate strength to those structures or components which should be difficult to repair if damaged by earthquake. The principles adopted for the aseismic design in the Tsuruga Plant are based on the experience in the construction of the Tokai Power Plant, and reference has also been made to design practices adopted in the west coast of the U.S.A. A description is given of how the design principles were established and how the aseismic design based on the principles were developed. The substance of the technical specifications for the aseismic design for the Tsuruga Nuclear Power Plant is described. 5 references. (auth)

23121 DUTCH NUCLEAR INDUSTRY. Energ. Nucl. (Paris); 12: 514-20(Nov-Dec 1970). (In French).

Due to far reaching efforts in the fields of technique and manufacture, the Dutch nuclear industry has been able to dominate a very large part of the foreign market, particularly for reactor vessels, core supports, heat exchangers and valves. This branch of the nuclear industry has already been given an order for 19 vessels. Once the anticipated extentions have been carried out, it will be possible to build four vessels per year. At present, national outlets for nuclear power stations are modest, and the Dutch industry is obliged to concentrate mainly on foreign markets. (auth) (France)

23122 CONSTRUCTION ON THE TAKAHAMA NUCLEAR POWER STATION. Hayashi, Akio (Kansai Electric Power Co. Inc., Osaka). Kensetsu No Kikaika; No. 247, 14-17(Sep 1970). (In Japanese).

Following No. 1 and 2 plants in the Mihama Power Station, Kansai Electric Power Company is proceeding with construction on the Takahama Nuclear Power Station, in Fukui Prefecture. The site is on a minor peninsula protruding into Wakasa Bay in the Japan Sea. It will go into commercial power generation in 1974. The power station employs a PWR of 826 MW(e), made by Westinghouse Electric Corp. The following are described: the reason for its construction; the progress; the location and topography of the site; the purchase of the main machinery; the schedule of the construction works; the arrangement plan of the power plant on the site; and the outline of the power station facilities, including a reactor plant, safety devices, a turbine generator, instruments and control equipment, and the waste processing facilities for gaseous, liquid and solid wastes, and earthquake-proof design. (Japan)

Operation and Economics

23123 (DOCKET-1155-106) LA CROSSE BOILING WATER REACTOR. Unplanned Reactor Shutdown. (Dairyland Power Cooperative, La Crosse, Wis.). 5 Mar 1971. 2p. (DPC-71-4). Dep. NTIS.

An unplanned reactor shutdown on March 5, 1971 is described. The seal inject system became unstable, causing pressure oscillations and operation of the N_2 backup supply to the forced circulation pump seals. Both forced circulation pumps tripped on the low seal inject pressure change of 80 psi resulting in a power to recirculation flow abnormal scram. The erratic seal injection operation was caused by air in the system from the incomplete venting during maintenance operations. (D.C.C.)

23124 (DOCKET-50029-148) YANKEE NUCLEAR POWER STATION. Operation Report No. 122, February 1971. (Yankee

Atomic Electric Co., Westboro, Mass.). 23 Mar 1971. 7p. Dep. NTIS.

23125 (DOCKET-50171-79) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 59, January 1971. (Philadelphia Electric Co., Pa.). 24 Mar 1971. 10p. Dep. NTIS.

23126 (DOCKET-50213-100) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 71-2, February 1971. (Connecticut Yankee Atomic Power Co., Haddam). 19 Mar 1971. Contract AT(30-1)-3250. 11p. (NYO-3250-57). Dep. NTIS.

23127 (DOCKET-50219-128) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Semi-Annual Report No. 3. Report of Operations, July 1-December 31, 1970 for Provisional Operating License No. DPR-16. (Jersey Central Power and Light Co., Morristown, N. J.). Feb 1971. 39p. Dep. NTIS.

23128 (DOCKET-50237-150) DRESDEN NUCLEAR POWER STATION, UNIT 2. Unplanned Liquid Release to the River. (Commonwealth Edison Co., Chicago, Ill.). 17 Oct 1970. 1p. Dep. NTIS.

23129 (DOCKET-50249-61) DRESDEN NUCLEAR POWER STATION, UNIT 3. Information Concerning a Jet Pump Problem. (Commonwealth Edison Co., Chicago, Ill.). 20 Mar 1971. 2p. Dep. NTIS.

23130 (DOCKET-50263-57) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Abnormal Occurrence Report: IRM Scram Settings Above 15 Percent of Rated Neutron Flux. (Northern States Power Co., Minneapolis, Minn.). 11 Mar 1971. 3p. Dep. NTIS.

23131 (DOCKET-50263-59) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Turbine Lockout Following Generator Trip Test from 15 Percent Power and Subsequent Events. (Northern States Power Co., Minneapolis, Minn.). 22 Mar 1971. 11p. Dep. NTIS.

23132 (EUR-4564) GUNDREMMINGEN (KRB) NUCLEAR POWER PLANT ANNUAL REPORT 1969. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). Oct 1970. 63p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 6,20.

After the damage to the blading of the LP section of the turbine in 1968, the plant was run from November 1968 with a debladed LP section and hence a reduced power of 155 MW. An inspection in January 1969 of the LP section, in particular of the gags fitted to reduce pressure, showed no faults, and operation was therefore continued at this power level. The fuel rod leaks already mentioned in the 1968 report increased further, causing a corresponding increase in the specific activity of the primary water, the primary steam and the off-gas. After completion of preliminary work, the plant was shut down on 30 May 1969 and the turbine repair was begun. At the same time the necessary overhead and maintenance work was done and the first refuelling operation was carried out. A detailed network plan was used to ensure optimum coordination of all this work. In the working out of this plan, it was necessary in addition to complying with all the safety criteria, to take special care to ensure that the radiation exposure of all employed personnel remained as low as possible. Full power was reached on 1 September 1968 and the plant was run without incident up to April 1970. (auth)

23133 (EUR-4565) OBRIGHEIM NUCLEAR POWER PLANT ANNUAL REPORT 1969. (Kernkraftwerk Obrigheim G.m.b.H., Stuttgart (West Germany)). 29 Sep 1970. 70p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 7,30.

Operations and maintenance requirements during January to December 1969 are described. (D.C.C.)

23134 (EUR-4566) ARDENNES NUCLEAR POWER PLANT ANNUAL REPORT 1969. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 15 Sep 1970. 30p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 5,60.

At the SENA nuclear power plant, 1969 was taken up mainly by repairs to the reactor internals, in which serious damage had been found at the beginning of 1968. At the end of the year, when all the repairs were completed, a series of static and dynamic tests were performed to verify the hypothesis taken as the basis for the repairs and to check their quality. Numerous adjustments were made throughout the year to most of the power plant equipment. These were checked by a brief period of operation at low power during tests on the reactor. (auth)

23135 (EUR-4596) LATINA NUCLEAR POWER PLANT ANNUAL REPORT 1969. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 4 Nov 1970. 42p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR Lit. 750.

The plant was shut down on 17 March to correct certain troubles encountered during the year. The results of the TV inspection of the reactor support plate showed that some of the secondary components, such as the thermocouple clamps and ducts, had become detached as a result of the failure of the fastening bolts. The plant shutdown lasted until 20 August 1969. During this period, besides general maintenance, some of the secondary components of the primary circuit which had been damaged by oxidation had to be repaired and replaced. While the power plant was being started up again, counts exceeding the mean values of the corresponding power levels were recorded by the BSD system, so that all the fuel channels had to be inspected at various power levels. The thermal power of the reactor was gradually increased by 2 MW/h and the activity of the gas released from the channels was measured continuously. The damaged elements, which were usually those corresponding to the fourth position, were replaced. On the basis of these findings it was decided to replace the MK1 elements previously used in the fourth position with MK2 elements. On 10 October 1969 the power plant resumed parallel grid operation at an output of about 160 MW(e). To limit the damage of primary circuit components by oxidation, the mean temperature of the gas released from the reactor was reduced from 390 to 360°C. During 1969 the gross output of the power plant was 496 626 064 kWh (including 16 280 kWh diesel production). The utilization factor was 26.99% throughout the year and 58.65%, leaving out the period from 27 March to 10 October, when the plant was out of service. At 31 December 1969 the Latina power plant had reached a gross production of 8 463 891 638 kWh (including 1 064 072 kWh diesel production). (auth)

23136 PACE OF DEVELOPMENT OF NUCLEAR POWER GENERATION. COMPETITION WITH OIL-BURNING POWER GENERATION. Takashima, Susumu (Ministry of International Trade and Industry, Tokyo). Sekiyu To Sekiyu Kagaku; 14: No. 11, 94-8(Oct 1970). (In Japanese).

The safety and economy of nuclear power generation and the role to be played in the overall power supply in the future are discussed. The demand in Japan in 1985 will be 930 to 1,030 million kl in terms of oil. Because of the low cost and stabilized supply of nuclear energy, the share of nuclear power generation will increase gradually. By 1985, about ¼ of the total power generation will be by nuclear energy. The development of ATR and FBR, in progress, is described. The potential for technical and economical improvement of nuclear power generation is great. Oil-burning power generation development has approached a limit point. (Japan)

23137 START UP OF TSURUGA NUCLEAR POWER STATION. Imai, Ryukichi (Japan Atomic Power Co., Tokyo); Kuge, Yasushi; Adachi, Mizuho; Yamazaki, Ryokichi; Fujie, Takao. Nippon Genshiryoku Gakkaishi; 12: 331-44(Jun 1970). (In Japanese).

The Tsuruga Nuclear Power Station (employing a BWR) of JAPC went into commercial power generation in March 1970; it was completed with a record speed of 46 months after start of the construction. The stages of startup of the BWR power plant, from September 1969 to March 1970, are first described, including the situation in each stage and various tests performed. The respective stages are fuel loading from September to October, nuclear heating (i.e., criticality and power generation) from October to November, and finally the power-up to commercial power generation from November to March. These tests included reactivity and control, recirculation system, nuclear and process instrumentations, etc. Finally, the design of nuclear fuel, fuel inspection, and the loading are described. (Japan)

23138 OPERATION EXPERIENCES OF THE JAPC TSURUGA POWER STATION. Iwakoshi, Yonesuke; Koshiro, Hideki (Japan Atomic Power Co., Tokyo). Doryoku; 20: No. 114, 18-22(Aug 1970). (In Japanese).

Construction was started on the BWR plant of the Tsuruga Power Station in April 1966. It went critical in October 1969 and subsequently into commercial power generation in March 1970. Despite this short period of construction, it is operating satisfactorily. First, the reactor plant is outlined: 322 MW(e), 308 fuel assemblies with UO_2 pellets, with 73 control rods. Then operating experiences of the BWR plant are described. (1) Test operation, including the fuel loading, from September 1969 to March 1970. Encountered during the period were the exchange of filters in the control-rod drive, drilling of equalizing holes in the turbine, exchange of neutron shields, strainer repair in condensation salt

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remover, etc. (2) Actual operation subsequent to the test operation. The reactor was scrammed by accident twice during the period. The problems of power-range neutron detectors, radiation leakage, etc. are also described. Finally, the mode of plant operation and the future inspection are briefed. (Japan)

23139 RATIONALE FOR LOW COST NUCLEAR HEAT AND ELECTRICITY. Lane, James A. (Oak Ridge National Lab., Tenn.). pp 26-36 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

A review of nuclear power plant costs for reactors currently in operation or under construction in the U.S. is presented. The increases in plant costs are analyzed. A reappraisal of future low cost nuclear power is presented in light of economic changes occurring since 1967. The projected plant costs for breeder reactors are listed. The effects of power plant size on costs are discussed. (D.C.C.)

23140 FUEL MANAGEMENT IN NUCLEAR POWER GENERATION. Brandfron, W. W. (Sargent and Lundy Engineers, Chicago). pp 71-84 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

Nuclear fuel cycle costs and management procedures for nuclear power plants are analyzed. (D.C.C.)

23141 OPERATING EXPERIENCE AT THE CONNECTICUT YANKEE REACTOR. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol.; 14: 7-29(Spring 1971).

The history of Connecticut Yankee operations from prestartup testing through September 1970 is summarized. Maintenance and repairs performed are described. 44 references. (H.D.R.)

23142 CAN ATOMIC ENERGY COMPETE WITH TRADITIONAL FUELS IN ELECTRICITY PRODUCTION? Henskens, A. Ingenieursblad; 39: 574-9(1970). (In Dutch).

After a short introduction covering the present state of Belgian electric power production based on traditional fuels, the transition towards atomic energy plants is examined. The prices of power production are discussed, and it is concluded that atomic energy is a competitive source of power if the plant runs long enough per year. The Belgian five year plan for building atomic power stations is described. (auth) (INIS)

Safety and Siting

23143 (DOCKET-1151-40) ELK RIVER REACTOR. Change Request No. 14 to the Technical Specifications of Operating Authorization No. DPRA-3. (Rural Cooperative Power Association, Elk River, Minn.). 15 Mar 1971. 3p. Dep. NTIS.

Revised technical specifications concerning the use of thermoluminescent dosimeters for environmental radiation monitoring are presented. (D.C.C.)

23144 (DOCKET-1155-107) LA CROSSE BOILING WATER REACTOR. Primary Piping and Reactor Vessel Leak Detection System Performance. (Dairyland Power Cooperative, La Crosse, Wis.). Feb 1971. 14p. (DPC-851-21). Dep. NTIS.

23145 (DOCKET-50003-66) INDIAN POINT STATION, UNIT NO. 1. Investigation of Materials Recovered from the Buffer Seal Housings of Core B. (Consolidated Edison Co. of New York, Inc., New York). 12 Mar 1971. 35p. Dep. NTIS.

23146 (DOCKET-50010-81) DRESDEN NUCLEAR POWER STATION, UNIT 1. Supplementary Information to Proposed Change No. 22 to Appendix A of License No. DPR-2. (Commonwealth Edison Co., Chicago, Ill.). 24 Mar 1971. 1p. Dep. NTIS.

Additional information concerning Cycle B fuel elements is presented. (D.C.C.)

23147 (DOCKET-50010-82) DRESDEN NUCLEAR POWER STATION, UNIT 1. License No. DPR-2; Supplement B to Proposed Change No. 17. Additional Information on Emergency Core Cooling System. (Commonwealth Edison Co., Chicago, Ill.). 23 Mar 1971. 20p. Dep. NTIS.

23148 (DOCKET-50016-103) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Order Extending Provisional Operating License Expiration Date. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 Mar 1971. 2p. Dep. NTIS.

23149 (DOCKET-50029-147) YANKEE NUCLEAR POWER STATION. Plans for Upgrading the Emergency Core Cooling System and Schedule for Transition to a Zircaloy Core. (Yankee Atomic Electric Co., Westboro, Mass.). 22 Mar 1971. 2p. Dep. NTIS.

23150 (DOCKET-50130-8) PATHFINDER GENERATING PLANT, SIOUX FALLS, SOUTH DAKOTA. Supplement to Technical Specifications Amendment 50 of License No. DPR-11. (Northern States Power Co., Minneapolis, Minn.). 23 Mar 1971. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the following topics: exclusion and restricted areas; operations personnel; and area and ventilation monitors. (D.C.C.)

23151 (DOCKET-50133-47) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7; Technical Specifications Proposed Change No. 33. (Pacific Gas and Electric Co., San Francisco, Calif.). 4 Mar 1971. 5p. Dep. NTIS.

Technical specifications concerning modified fuel assemblies for Cycle 7 operation are presented. Design parameters for modified fuel assemblies are listed. (D.C.C.)

23152 (DOCKET-50133-49) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Change No. 30 to the Technical Specifications of the Provisional Operating License No. DPR-7. (Division of Reactor Licensing (AEC), Washington, D. C.). 10 Mar 1971. 2p. Dep. NTIS.

Revised technical specifications concerning maximum withdrawal rates for the control rods are presented. (D.C.C.)

23153 (DOCKET-50146-70) SAXTON REACTOR. Change Report No. 24. Modifications to Primary Coolant Sampling System. (Saxton Nuclear Experimental Corp., Pa.). 10 Mar 1971. 8p. Dep. NTIS.

23154 (DOCKET-50155-73) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6; Technical Specifications Change No. 24. (Division of Reactor Licensing (AEC), Washington, D. C.). 3 Mar 1971. 7p. Dep. NTIS.

Revised technical specifications concerning two new centermelt fuel bundles are presented. Design parameters for the two new centermelt fuel bundles and the 5 original centermelt fuel bundles planned for reactor operation are listed. (D.C.C.)

23155 (DOCKET-50155-76) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6; Proposed Technical Specifications Change No. 27, Additional Information. (Consumers Power Co., Jackson, Mich.). 3 Mar 1971. 2p. Dep. NTIS.

An illustration of the pipe layout for the backup core spray nozzle system is presented. (D.C.C.)

23156 (DOCKET-50171-80) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Request for Change in Technical Specifications (No. 14) of License No. DPR-12. (Philadelphia Electric Co., Pa.). 23 Mar 1971. 13p. Dep. NTIS.

Revised technical specifications concerning design parameters and performance requirements of FPTE-3 fuel pin are presented. (D.C.C.)

23157 (DOCKET-50171-81) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Request for Change in Technical Specifications (No. 15) of License No. DPR-12. (Philadelphia Electric Co., Pa.). 23 Mar 1971. 9p. Dep. NTIS.

Revised technical specifications concerning post-irradiation examination of control rods and guide sleeves are presented. (D.C.C.)

23158 (DOCKET-50206-107) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Provisional Operating License No. DPR-13, Amendment 21. Request for Extension of Expiration Date of Provisional Operating License to September 27, 1972. (Southern California Edison Co., Los Angeles). 18 Mar 1971. 4p. Dep. NTIS.

23159 (DOCKET-50206-108) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Provisional Operating License No. DPR-13, Amendment 22. Revision to Proposed Change No. 4 to Technical Specifications. (Southern California Edison Co., Los Angeles). 23 Mar 1971. 17p. Dep. NTIS.

Revised technical specifications concerning control rod insertion limits for Cycle 2 operations are presented. (D.C.C.)

23160 (DOCKET-50213-101) CONNECTICUT YANKEE ATOMIC POWER PLANT. Proposed Change No. 19 to Technical Specifications of Provisional License No. DPR-14. (Connecticut Yankee Atomic Power Co., Hartford). 22 Mar 1971. 17p. Dep. NTIS.

Revised technical specifications are presented concerning the emergency power system. (D.C.C.)

23161 (DOCKET-50219-126) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Change Request No. 6 to Technical Specifications of the Provisional Operating License No. DPR-16. (Jersey Central Power and Light Co., Morristown, N. J.). 3 Mar 1971. 11p. Dep. NTIS.

Revised technical specifications concerning protective instrumentation requirements are presented. The specifications provide core flux monitoring capabilities if installed detectors are not available. (D.C.C.)

23162 (DOCKET-50219-129) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Change No. 6 to the Technical Specifications of License No. DPR-16. (Division of Reactor Licensing (AEC), Washington, D. C.). 18 Mar 1971. 3p. Dep. NTIS.

Revised technical specifications concerning auxiliary core flux monitoring equipment are presented. (D.C.C.)

23163 (DOCKET-50220-61) NINE MILE POINT NUCLEAR STATION. Response to ACRS Questions Regarding Request for an Increase to 1850 MW(t). (Niagara Mohawk Power Corp., Syracuse, N. Y.). 12 Mar 1971. 3p. Dep. NTIS.

23164 (DOCKET-50237-149) DRESDEN NUCLEAR POWER STATION, UNIT 2. Maximum Power Level Increased to 2527 MWt. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 Oct 1970. 2p. Dep. NTIS.

23165 (DOCKET-50250-42) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report, [Amendment 34], Suppl. 34 (Includes Final Safety Analysis Report, Rev. 13). (Florida Power and Light Co.). 17 Mar 1971. 42p. (DOCKET-50251-38). Dep. NTIS.

Emergency plans for possible accidents associated with the reactor and operation personnel are described. (D.C.C.)

23166 (DOCKET-50254-32) QUAD-CITIES STATION, UNITS 1 AND 2. Notice of Consideration of Issuance of Facility Operating Licenses. (Division of Reactor Licensing (AEC), Washington, D. C.). 11 Mar 1971. 5p. (DOCKET-50265-28). Dep. NTIS.

23167 (DOCKET-50255-34) PALISADES PLANT. Control Rod Modifications to Improve the Operating Performance. (Consumers Power Co., Jackson, Mich.). 15 Mar 1971. 2p. Dep. NTIS.

23168 (DOCKET-50255-35) PALISADES PLANT. Issuance of Interim Provisional Operating License No. DPR-20. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Mar 1971. 185p. Dep. NTIS.

For Consumers Power Co., Jackson, Mich.

Notice of issuance of the interim provisional operating license is presented. Technical specifications are included. (D.C.C.)

23169 (DOCKET-50261-53) H. B. ROBINSON UNIT NO. 2. Pre-Operational Environmental Monitoring Report, January 1-September 30, 1970. (Eberline Instrument Corp., Santa Fe, N. Mex. Dept. of Nuclear Sciences). 12 Mar 1971 34p. Dep. NTIS.

For Carolina Power and Light Co., Raleigh, N. C.

23170 (DOCKET-50263-58) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Change Request No. 1 to Technical Specifications Appendix A of Provisional Operating Licensing No. DPR-22. (Northern States Power Co., Minneapolis, Minn.). 15 Mar 1971. 11p. Dep. NTIS.

Revised technical specifications concerning protection factors for personnel respiratory protection equipment are presented. (D.C.C.)

23171 (DOCKET-50282-32) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 8. Technical Specifications. (Northern States Power Co., Minneapolis, Minn.). 9 Mar 1971. 164p. (DOCKET-50306-32). Dep. NTIS.

23172 (DOCKET-50285-43) FORT CALHOUN STATION, UNIT NO. 1. Applicant's Environmental Report, Operating License Stage. (Omaha Public Power District, Nebr.) 24 Mar 1971. 156p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

23173 (DOCKET-50289-33) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 18 (Includes Final Safety Analysis Report Modifications). (Metropolitan Edison Co., Reading, Pa. Jersey Central Power and Light Co., Morristown, N. J. Pennsylvania Electric Co., Johnstown). 22 Mar 1971. 230p. Dep. NTIS.

Revised and additional design parameters on the reactor requested by the Division of Reactor Licensing are presented. (D.C.C.)

23174 (DOCKET-50293-40) PILGRIM NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 22 (Includes Additions and Revisions to Final Safety Analysis Report). (Boston Edison Co., Mass.). 15 Mar 1971. 44p. Dep. NTIS.

Revised information on radiation monitoring program for the reactor site is presented. The emergency plan relating to possible reactor accidents is included. Qualifications of startup personnel are listed. (D.C.C.)

23175 (DOCKET-50293-41) PILGRIM NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 23 (Includes Additions and Revisions to Final Safety Analysis Report). (Boston Edison Co., Mass.). 16 Mar 1971. 14p. Dep. NTIS.

Additional data on design parameters and operations aspects of the reactor requested by the Division of Reactor Licensing are presented. (D.C.C.)

23176 (DOCKET-50293-42) PILGRIM NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 24 (Includes Additions and Revisions to Final Safety Analysis Report). (Boston Edison Co., Mass.). 18 Mar 1971. 32p. Dep. NTIS.

Additional data on the design parameters and operations aspects of the reactor requested by the Division of Reactor Licensing are presented. (D.C.C.)

23177 (DOCKET-50293-43) PILGRIM NUCLEAR POWER STATION. Preoperational Environmental Radiation Survey Program, September 1-December 31, 1970. (ICN/Tracerlab, Waltham, Mass.). 18 Mar 1971. 31p. Dep. NTIS.

For Boston Edison Co., Mass.

23178 (DOCKET-50293-44) PILGRIM NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 26 (Includes Additions and Revisions to Final Safety Analysis Report). (Boston Edison Co., Mass.). 24 Mar 1971. 87p. Dep. NTIS.

Revised design parameters of the Pilgrim Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

23179 (DOCKET-50293-45) PILGRIM NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 27 (Includes Additions and Revisions to Final Safety Analysis Report). (Boston Edison Co., Mass.). 29 Mar 1971. 85p. Dep. NTIS.

Revised design parameters of the Pilgrim Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

23180 (DOCKET-50295-25) ZION STATION, UNITS 1 AND 2. Additional Information Relative to Application for Construction Permits and Operating Licenses. (Commonwealth Edison Co., Chicago, Ill.). 19 Mar 1971. 15p. (DOCKET-50304-25). Dep. NTIS.

Requested additional information is presented concerning the liner bulge in the Unit 2 containment structure. Information is also presented on voids at concrete-buttress plate joint of the Unit 2 containment structure. Materials specifications for the tendon sheathing and fly ash analysis for concrete aggregate are included. (D.C.C.)

23181 (DOCKET-50298-17) COOPER NUCLEAR STATION. Preliminary Safety Analysis Report, Amendment 7. Final Safety Analysis Report, Vol. 5. (Consumers Public Power District, Columbus, Nebr.). 26 Feb 1971. 263p. Dep. NTIS.

Information on Cooper Power Reactor is presented under the following broad topics: structures and shielding; conduct of operations; and station safety analysis. (D.C.C.)

23182 (DOCKET-50302-23) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Environmental Status Report, October-December 1970. (Florida Power Corp., St. Petersburg). 15 Mar 1971. 80p. Dep. NTIS.

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23183 (DOCKET-50309-30) MAINE YANKEE ATOMIC POWER STATION. Preliminary Safety Analysis Report, Amendment 20. (Maine Yankee Atomic Power Co., Westboro, Mass.). 10 Mar 1971. 84p. Dep. NTIS.

Revised and additional information concerning the design parameters and operations aspects of Maine Yankee Power Reactor is presented. (D.C.C.)

23184 (DOCKET-50321-18) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 9. Final Safety Analysis Report, Vol. 1. (Georgia Power Co., Atlanta). 12 Mar 1971. 315p. Dep. NTIS.

Information on Edwin I. Hatch Power Reactor Unit 1 is presented under the broad topics of site and environment, and reactor. (D.C.C.)

23185 (DOCKET-50321-19) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 9. Final Safety Analysis Report, Vol. 2. (Georgia Power Co., Atlanta). 12 Mar 1971. 218p. Dep. NTIS.

Information on Edwin I. Hatch Power Reactor Unit 1 is presented under the following broad topics: cooling system; containment systems; and core standby cooling systems. (D.C.C.)

23186 (DOCKET-50321-20) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 9. Final Safety Analysis Report, Vol. 3. (Georgia Power Co., Atlanta). 23 Mar 1971. 317p. Dep. NTIS.

Information on control systems and instrumentation for the Edwin I. Hatch Power Reactor Unit 1 is presented. (D.C.C.)

23187 (DOCKET-50321-21) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 9. Final Safety Analysis Report, Vol. 4. (Georgia Power Co., Atlanta). 21 Mar 1971. 439p. Dep. NTIS.

Information on Edwin I. Hatch Power Reactor Unit 1 is presented under the following broad topics: electrical power systems; radioactive waste systems; auxiliary systems; power conversion systems; structures and shielding; conduct of operations; and plant safety analysis. (D.C.C.)

23188 (DOCKET-50321-22) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 9. Final Safety Analysis Report, Vol. 5. (Georgia Power Co., Atlanta). 12 Mar 1971. 213p. Dep. NTIS.

Information on Edwin I. Hatch Power Reactor Unit 1 is presented under the following topics: pressure integrity of piping; quality assurance program; conformance to AEC criteria; plant nuclear safety operational analysis; in-service inspection program; and resolution of AEC-ACRS concerns and questions. (D.C.C.)

23189 (DOCKET-50341-28) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Report on ACRS' Review of Construction Application. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). 9 Mar 1971. 4p. Dep. NTIS.

23190 (DOCKET-50346-19) DAVIS-BESSE NUCLEAR POWER STATION. Construction Permit No. CPPR-80. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Mar 1971. 48p. Dep. NTIS.

23191 (DOCKET-50348-17) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 11. (Alabama Power Co., Birmingham). 24 Feb 1971. 235p. (DOCKET-50364-11). Dep. NTIS.

Revised design parameters of the Joseph M. Farley Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

23192 (DOCKET-50348-18) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 12. (Alabama Power Co., Birmingham). 10 Mar 1971. 64p. (DOCKET-50364-12). Dep. NTIS.

Revised design parameters of the Joseph M. Farley Power Reactor Units 1 and 2 are presented. Included also are additional data requested by the Division of Reactor Licensing. (D.C.C.)

23193 (DOCKET-50354-12) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 5. (Public Service Electric and Gas Co., Newark, N. J.). 24 Mar 1971. 175p. (DOCKET-50355-12). Dep. NTIS.

Revised design parameters of the Newbold Island Power Reactor Units 1 and 2 are presented. Included also are additional information requested by the Division of Reactor Licensing. (D.C.C.)

23194 (DOCKET-50361-16) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Amendment 8. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 4 Mar 1971. 429p. (DOCKET-50362-15). Dep. NTIS.

Revised design parameters of the San Onofre Power Reactor Units 2 and 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. Quality assurance program requirements for the turbine generators are presented. (D.C.C.)

23195 (DOCKET-50363-13) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 7. (Jersey Central Power and Light Co., Morristown, N. J.). 19 Mar 1971. 529p. Dep. NTIS.

Revised design parameters of the Forked River Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

23196 (DOCKET-50367-10) BAILLY GENERATING STATION, NUCLEAR I. Preliminary Safety Analysis Report, Amendment 3. (Northern Indiana Public Service Co., Hammond). 18 Mar 1971. 601p. Dep. NTIS.

Additional data on the design parameters and operations aspects of the reactor requested by the Division of Reactor Licensing are presented. (D.C.C.)

23197 (DOCKET-50367-11) BAILLY GENERATING STATION, NUCLEAR I. Environmental Report. (Northern Indiana Public Service Co., Hammond). 22 Mar 1971. 304p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

23198 (DOCKET-50369-7) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 2. (Duke Power Co., Charlotte, N. C.). 22 Mar 1971. 254p. (DOCKET-50370-6). Dep. NTIS.

Revised design parameters of the McGuire Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

23199 (IAEA-R-711-F) DEVELOPMENT OF SAFEGUARDS PROCEDURES FOR HEAVY WATER MODERATED, COOLED AND REFLECTED PRESSURIZED WATER TYPE REACTORS. Haefele, W.; Gupta, D. (International Atomic Energy Agency, Vienna (Austria)). Feb 1970. 26p. NTIS (U. S. Sales Only).

After an analysis of the layout of the Atucha reactor, the logical structure of the proposed safeguards measures has been evolved. The basic measures are confirmation of the final routes as given by the operator; sealing, identification and checking the integrity of the fuel subassemblies; checking the movement of the subassembly moving mechanisms along the fuel routes; and monitoring the radiation level in the reactor bay area. Besides this, the inspection organization will receive information on integrated power generated, and shutdown history of the reactor at regular intervals. The instrument, accessories and actions required to implement these measures are described. A typical inspection visit to the Atucha reactor is analyzed. An estimate of the efforts required to carrying out some development work is presented. (auth) (INIS)

23200 (IAEA-R-735-F) ANALYSIS OF POSSIBILITY OF ESTIMATING THE QUALITY OF PLUTONIUM PRODUCED IN A NUCLEAR POWER PLANT ON THE BASIS OF MEASURED QUANTITY OF GENERATED ELECTRICITY. Drahny, M. (International Atomic Energy Agency, Vienna (Austria)). 1970. 52p. NTIS (U. S. Sales Only).

Inspection criteria for the production of fissile materials in power reactors are described. The feasibility of using the electricity generated in a power reactor as a safeguards measurement of the minimum quantity of plutonium produced in that reactor was determined. It is assumed that for a particular plant the following data will be available: continuous measurements of the amount of generated electricity as well as certain characteristics of the reactor design. In connection with the latter, the thermal and electrical schemes of the main circuits of the plant and dependency of the quantity of plutonium on the burnup of fuel elements used should be known. It is concluded that the electric power output from the plant, taking into account the self-consumption of electricity, can be measured simply and with acceptable accuracy without restricting the reactor operations. At

the same time, it is possible to measure integral quantities and to record the time characteristics of the measured quantities. In order to avoid uncertainties in the final result of this safeguards measurement, recommendations are given about the actual burnup of exchanged fuel or the speed of the fuel exchange and the relation between the thermal and the electric output power of the reactor. (INIS)

23201 (ORNL–4652) THERMAL DISCHARGE: CHARACTERISTICS AND CHEMICAL TREATMENT OF NATURAL WATERS USED IN POWER PLANTS. Marshall, William L. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 12p. Dep. NTIS.

Several factors relating to the discharge of thermal waters to the environment from electrical power plants are reviewed. A survey of the chemical constituents of natural waters with respect to dissolved solids and gases, and their expected behavior on throughput of natural water coolants, is presented. The current practices in chemically treating natural waters for use as coolants are described in relation to the ultimate discharge of these chemicals to the environment. All types of thermal power plants are considered briefly, including dual-purpose plants that also desalinate water. Knowledge of chemical additives in thermal discharges is important for studies of the combined effect on the ecology of changes both in temperature and composition of natural waters. (auth)

23202 (WHAN-IR–53) ENVIRONMENTAL ENGINEERING PROGRAMS QUARTERLY TECHNICAL PROGRESS REPORT, JULY–SEPTEMBER 1970. Hofmann, P. L. (comp.) (Hanford Engineering Development Lab., Richland, Wash.). Dec 1970. Contract AT(45-1)-2170. 14p. Dep. NTIS.

The development of COL HEAT and TOPLYR computer programs for simulating the capacities of surface waters for nuclear power plant thermal effluents is described. The cooling capacities of the Ohio River and the Missouri River are calculated. (D.C.C.)

23203 SAFETY CONCERNING THE ALTERATION OF THE FUKUSHIMA ATOMIC POWER STATION, TOKYO ELECTRIC POWER COMPANY: ADDITION OF NO. 3 REACTOR PLANT. Genshiryoku Iinkai Geppo; 15: No. 1, 2-12(Jan 1970). (In Japanese).

An application was made to the Government by Tokyo Electric Power Company for the permission of adding No. 3 reactor plant to the Fukushima atomic power station. In this connection, safety aspects of the addition including the plant system were inspected by the ad hoc group within the Japanese AEC. Main features of the reactor plant are: a direct-cycle, forced-circulation BWR, with 2380 MW(t) (780 MW(e)); cylindrical containment pressure vessel with dry-well and suppression chambers; fueled by low-enriched UO_2 and controlled by B_4C. The results of inspections are described in the following: site conditions; safety design and measures, including plant components etc.; radiation exposures during normal operation; various ordinary accidents; major hazardous accidents; and the schedule of inspections employed. (Japan)

23204 NUCLEAR POWER AND THE PUBLIC. Symposium Held at Minneapolis, October 10–11, 1969. Foreman, Harry (ed.). Minneapolis; University of Minnesota Press (1970). 289p. $9.00. (CONF-691054).

Information on safety aspects of nuclear power plants is presented. Separate abstracts are included for each of the 13 papers presented. (D.C.C.)

For abstracts of individual papers see: 23110, and 23205–23216.

23205 BASIC INFORMATION ABOUT REACTORS. Bray, A. Philip (General Electric Co., San Jose, Calif.). pp 3-28 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Design parameters and operations aspects of boiling water reactors are described. Engineered safeguards required for power reactor operation are reviewed. Radioactive waste disposal systems for boiling water reactors are described. Radioactive effluents from nuclear power plants are analyzed. (D.C.C.)

23206 ECOLOGICAL CONSIDERATIONS IN SITING NUCLEAR POWER PLANTS: THE PROBLEM OF LONG-TERM BIOTIC EFFECTS. Auerbach, Stanley I. (Oak Ridge National Lab., Tenn.). pp 29-44 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Projected long-term effects on the environment of radioactive effluents from nuclear power plants are presented. 20 references. (D.C.C.)

23207 REGULATION OF MAN-MADE RADIATION IN THE BIOSPHERE. Tamplin, Arthur R. (Univ. of California, Livermore). pp 45-51 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Projected limits for radioactive effluents from nuclear power plants are presented. Proposed hazards related to upper limit doses are analyzed. 12 references. (D.C.C.)

23208 EFFECTS OF HEATED WATER FROM NUCLEAR PLANTS ON AQUATIC LIFE. Brungs, William A. (Federal Water Pollution Control Administration, Cincinnati). pp 52-9 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

23209 ENVIRONMENTAL MONITORING AND SURVEILLANCE. Lieberman, Joseph A.; Harward, Ernest D.; Weaver, Charles L. (Public Health Service, Washington, D. C.). pp 60-72 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Environmental radiation monitoring program requirements for nuclear power plants are described. 10 references. (D.C.C.)

23210 STANDARDS OF RADIATION PROTECTION AND THEIR IMPLICATIONS FOR THE PUBLIC'S HEALTH. Eisenbud, Merril (Environmental Protection Administration, New York). pp 73-89 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

The development of radiation standards is reviewed. The responsibilities of the U.S. Atomic Energy Commission concerning radiation standards are discussed. 17 references. (D.C.C.)

23211 EVALUATION OF HEALTH HAZARDS TO THE PUBLIC ASSOCIATED WITH NUCLEAR POWER PLANT OPERATIONS. Stannard, J. Newell (Univ. of Rochester, N. Y.). pp 90-123 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

The basis for current maximum permissible exposure levels to radiation and radioisotopes is analyzed. Possible hazards from nuclear power plant radioactive effluents are discussed. 4 references. (D.C.C.)

23212 RISK BENEFIT CALCULUS IN NUCLEAR POWER LICENSING. Green, Harold P. (George Washington Univ., Washington, D. C.). pp 124-38 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Criticism of the present U.S. Atomic Energy Commission licensing procedures for nuclear power plants is presented. (D.C.C.)

23213 FEDERAL PREEMPTION OF REGULATION OF RELEASES OF RADIONUCLIDES FROM NUCLEAR POWER PLANTS: A LEGAL HISTORY AND RATIONALE. Hosmer, Craig (Joint Committee on Atomic Energy, Washington, D. C.). pp 139-67 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Atomic Energy Commission licensing and regulatory procedures for nuclear power plants are described. A discussion concerning federal government and state government responsibilities for regulating radioactive effluents from nuclear power plants is presented. (D.C.C.)

23214 POLICIES AFFECTING THE ENERGY NEEDS OF SOCIETY. Freeman, S. David (Energy Policy Staff, Washington, D. C.). pp 168-78 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Predicted power requirements in the U.S. are described. Regu-

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lations concerning construction and operation of nuclear power plants are discussed. (D.C.C.)

23215 NUCLEAR POWER: BENEFITS AND RISKS. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). pp 207-23 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Safety aspects of nuclear power plants are discussed. Responsibilities for regulating radioactive and thermal effluents from nuclear power plants are analyzed. 15 references. (D.C.C.)

23216 NUCLEAR POWER: BENEFITS AND RISKS. Commoner, Barry (Washington Univ., St. Louis). pp 224-55 of Nuclear Power and the Public. /Foreman, Harry (ed.). Minneapolis; Univ. of Minnesota Press (1970).

From Nuclear Power and the Public Conference, Minneapolis, Minn. See CONF-691054.

Responsibilities for regulating radioactive effluents from nuclear power plants are analyzed. Possible radiation hazards from nuclear power plants are discussed. 8 references. (D.C.C.)

23217 NUCLEAR POWER PLANT SITING QUESTIONS. SINGLE- AND MULTI-PURPOSE INSTALLATIONS. Mandel, H. (Vorstandsmitglied der Rheinisch-Westfaelisches Elektrizitaetswerk, Essen). Atomwirt., Atomtech.; 16: 22-6(Jan 1971). (In German).

Factors determining site selection can be classified in two orders of significance. The first order, primarily springing from the purpose of the installation, determines the general location of the plant. Factors of the second order, arising from attempts to optimize economic conditions, reside in the local situation and determine the site more closely. First order effects comprise the cooling system and proximity to the high-voltage power grid. Second order effects comprise cost estimates of river water cooling, connection to the power grid, conditions of soil and ground water level, seismic influences, flood insurance, railroad- and waterway connections, and acreage permitting future expansion. Location of power plants on the seashore presents special problems that are briefly outlined. (H.B.G.)

23218 BALANCED ENVIRONMENT: THE IMPACT OF THERMAL ELECTRIC POWER GENERATION ON THE ENVIRONMENT. Train, Russell E. (Under Secretary of the Interior, Washington, D. C.). pp 55-60 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

The effects of thermal discharges from fossil fuel and nuclear power plants on the environment of the U.S. are analyzed. (D.C.C.)

23219 REGULATORY PROGRAM OF THE U. S. ATOMIC ENERGY COMMISSION. Price, Harold L. (Atomic Energy Commission, Washington, D. C.). pp 105-16 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

A review of AEC responsibilities in the design, construction, and operation of nuclear power plants is presented. (D.C.C.)

23220 THERMAL EFFECTS ON ECOLOGICAL SYSTEMS. Bartsch, A. F. (Dept. of the Interior, Corvallis, Oreg.); Mount, D. I. pp 117-24 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

23221 RADIATION CONTROL IN NUCLEAR POWER INSTALLATIONS. Brush, Harvey F. (Bechtel Corp., San Francisco). pp 125-32 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

Safety regulations concerning radioactive effluents from nuclear power plants are described. (D.C.C.)

23222 ECONOMIC GROWTH AND ENVIRONMENTAL EFFECTS OF NUCLEAR ENERGY DEVELOPMENT. Clapper, Louis S. (National Wildlife Federation, Washington, D. C.). pp 135-42 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

Considerations given to the development and operation of nuclear power plants which will not have adverse effects on the environment are presented. (D.C.C.)

23223 RADIOLOGICAL ASPECTS OF AIR AND WATER: DISCHARGES FROM NUCLEAR POWER INSTALLATIONS. Goldman, Morton I. (NUS Corp., Rockville, Md.). pp 144-58 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

Typical waste management systems at nuclear power plants are described. Waste discharge limits are discussed. Operating experience for waste discharge systems at nuclear power plants is reviewed. Biological implications of radioactive water discharges are analyzed. (D.C.C.)

23224 AVOIDANCE OF POLLUTION IN THE DISPOSAL OF RADIOACTIVE WASTES. Dunster, H. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 159-65 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

Safety limits for release of radioactive effluents from nuclear power plants are discussed. Possible hazards from radioactive waste are analyzed. (D.C.C.)

23225 SAFETY OF NUCLEAR REACTORS. Tamplin, Arthur R. (Univ. of California, Livermore). pp 166-82 of Northwest Conference on the Role of Nuclear Energy. Portland, Oreg.; Governor's Nuclear Development Coordinating Committee (1970).

From 2nd Annual Governor's Conference on Conservation, Portland, Oreg. See CONF-691223.

Possible hazards related to nuclear power plants are discussed. (D.C.C.)

23226 IN-SERVICE INSPECTION OF NUCLEAR REACTOR COOLANT SYSTEMS. Weissert, L. R. (Babcock and Wilcox Co., Lynchburg, Va.). Reactor Technol.; 14: 44-67(Spring 1971).

With the incorporation of new codes as proposed rules in the Code of Federal Regulations and the release of Section XI of the ASME Boiler and Pressure Vessel Code, the development and application of in-service inspection have accelerated. All significant literature to September 1970, the major developments and experiences on operating reactors, and the implications on reactor system design and plant operation and maintenance are reviewed. 32 references. (auth)

23227 SAFETY MEASURES ASSOCIATED WITH THE DEVELOPMENT OF ATOMIC ENERGY. ENVIRONMENTAL SAFETY. Sakagishi, Shokichi (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 4, 129-32(Apr 1970). (In Japanese).

The measures taken and to be taken in future and the investigations, concerning environmental safety of nuclear installations, are described in the following: large-scale nuclear installations and environmental safety, dealing with release of radioactive materials to the atmosphere and of low-level liquid wastes into the sea; major possible accidents and possible worst accidents; instances of released radioactive gaseous and liquid wastes in Tokai; monitoring of the environmental radioactivities; and future problems in environmental safety. (Japan)

23228 SAFETY AND NUCLEAR POWER PLANTS. Farmer, T. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Atom (London); No. 171, 6-9(Jan 1971).

In the development of atomic energy over the last twenty years, safety has always been one of the major objectives, and, already, the new processes and reactors in use in the U. K., have higher efficiency and more effective control of waste products than the earlier plants. The avoidance of severe accidents is the key to the future success of the industry, yet it is the difficulty of discussing accidents which have not yet happened which gives rise to the frequent and unsatisfactory discussion of safety in atomic energy. The industry is required to eliminate accidents without the benefit of experience of small or medium accidents — the conventional way in which industrial society has developed. The reactor is safe if the fuel is kept at, or near its operating temperature. The requirements for safety can be generalized as follows: —the pressure system must not leak excessively, the heat production must remain under control, coolant pumps or blowers must operate, water must be supplied to the boilers. (UK)

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23229 DIRECTIONS FOR RECORDING OF DAMAGES. Krischke, H.; Hoelker, F.-J. (Steinkohlen-Elektrizitaet AG, Essen). Mitt. Ver. Grosskesselbetr.; 50: 332-5(1970). (In German).

The "Directions for recording of failures and shutdown times in thermal power plants," edition 1969, of VDEW are described. In principle, they are valid for steam, gas turbine, and nuclear power plants. The recording procedures and characteristics are to be consistent for all types of thermal power plants. Only the component codes are different. They are decoded for each plant type in distinct arrangements in the appendix of the directions. Appendix C for nuclear power plants, however, is still in preparation. Appendix A for steam power plants with fossil fuels, which is already published, is illustrated briefly. (INIS)

Steam and Power Conversion Systems

23230 VIBRATION DUE TO A GAS FLOW: THE CASE IN A GAS-COOLED REACTOR. Ito, Haruo (Chubu Electric Power Co. Inc., Nagoya, Japan). Chubu Denryoku K. K. Kenkyu Shiryo; No. 45, 96-102(May 1970). (In Japanese).

There are many instances in which the structural components of a primary system have vibrated due to a gas flow in a gas-cooled reactor. This has also occurred several times in the Calder Hall type reactor of the JAPC Tokai power station. Of these, the vibration of the heat-transfer tubes in a heat-exchanger during its test operation is most typical of the vibration due to a gas flow. Since the vibration was unfamiliar, it presented significant difficulty, the repair itself taking about six months. The background for the occurrence of this vibration, and the measures taken are first described. And the causes for vibrations in a gas-cooled reactor are discussed on the basis of experiences gained in the vibrations of the Tokai power station. Finally, cautions in the prevention of vibrations are explained. (Japan)

Power Reactor Development

Refer also to abstracts 22010 and 22050.

23231 (ANL–7776) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JANUARY 1971. (Argonne National Lab., Ill.). 19 Feb 1971. Contract W-31-109-eng-38. 135p. Dep. NTIS.

Highlights of project activities for January 1971 are summarized. LMFBR physics and component development studies are reviewed. Operations and analysis of ZPR-6, ZPR-9, and ZPPR are described. The EBR-II research and development projects, fuel fabrication, and maintenance during shutdown are summarized. Reactor fuels and materials development, physics studies, engineering development, fuel cycle chemistry, LMFBR safety studies, and engineered safeguards analyses are reported. (H.D.R.)

23232 (TID–8200(23rd Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1970. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 36p. Dep. NTIS.

Information about facilities in the U. S. capable of sustaining a nuclear chain reaction is tabulated. The name of the facility is listed with location, principal nuclear contractor, type, power, and startup date. The facilities are categorized as: civilian reactors, production reactors, military reactors, reactors for export, and critical assemblies. (D.C.C.)

23233 ATOMIC POWER STATION: ADVANCED GAS-COOLED REACTOR. Atomu; 15: No. 2, 32-9(Feb 1970). (In Japanese).

The advanced gas-cooled reactor (AGR), based on the extended experiences of Magnox, gas-cooled reactors, will be invariably used in the second atomic power generation program of the United Kingdom. Compared with the Magnox type, the efficiency and the safety are further increased, and the capital charges decreased. Outstanding features include the high-temperature gas at low pressure, leading to good-quality steam; the stainless-steel cladding and the containment of core and primary system in a pressure vessel, resulting in the superior safety; and fuel exchange during the reactor operation, providing a high operation efficiency. The following are described: features of the AGR reactor, including the core, core shielding, gas baffle, coolant passage, gas circulator and boiler; choice of the parameters; safety, including the concrete pressure vessel, fuel and cladding tubes; and the state of AGR utilization. (Japan)

23234 DESIGN CONSIDERATION CONCERNING THE COMPONENTS AND EQUIPMENT OF A BWR PLANT, AND THE PROBLEMS. Yoshiyanagi, Kiyomi (Hitachi Ltd., Ibaraki, Japan). Nippon Kikai Gakkaishi; 73: 578-84(Apr 1970). (In Japanese).

In Japan, several atomic power stations employing BWRs are either in operation or under construction. Considerable experience has been gained and also technology acquired in Japan in construction of the containment and pressure vessels, reactor components, etc. And the possibility of domestic manufacture of the future nuclear power stations is high. The following are described: improvement in BWRs, dealing with the standardization of components etc., integration of a steam-water separator, and a jet pump; design standards, dealing with ASME Section III, and various stresses and permissible stresses; seismological considerations, including the earth-quake-resistant design etc.; safety considerations, including reactivity and mechanical accidents; and consideration of the radioactive wastes. (Japan)

23235 NATURE OF THE PERMISSIONS GOVERNED BY THE NUCLEAR REGULATION LAW. Ara, Hide (Yokohama National Univ., Japan). Denryoku Shinpo; No. 186, 92-5(Jun 1970). (In Japanese).

The nuclear regulation law refers to the "law on the regulation of nuclear materials, nuclear fuels and nuclear reactors" Despite the situation in which significance of atomic energy is being increasingly appreciated, the law or regulations thereon have not been studied from the standpoint of jurisprudence. The nature of the nuclear regulation law is examined on the following, giving appropriate interpretations: (1) Criteria for the permissions. The financial and account capability of enterprises for fuel processing and reactor installation, in particular, as against the case of other enterprises, is described; and also systematic pursuit by the enterprises. (2) Permission for installation of reactor plants. The characteristics are treated from the points of view of national economy, peaceful utilization, etc. (Japan)

23236 REPORT OF THE STUDY GROUP ON NUCLEAR POWER. Nippon Kikai Gakkaishi; 73: 216-18(Feb 1970). (In Japanese).

Atomic power stations are being built one after another in Japan. The role to be played by private enterprises, by research institutions, and by academic societies is discussed. There should be channels connecting the organizations. What the Japan Society of Mechanical Engineers should do under the circumstances is reviewed among the many problems of nuclear power development and utilization. The following are described: problems in the development and design of nuclear power plants; engineering problems in the safety of the Advanced Thermal Reactor and the Fast Breeder Reactor; problems in irradiation in JMTR; and problems in reactivity accidents. (Japan)

23237 DIRECTION OF THE DEVELOPMENT OF POWER REACTORS. LIGHT-WATER REACTORS. Togo, Yasumasa (Tokyo Univ.). Genshiryoku Kogyo; 16: No. 4, 27-31(Apr 1970). (In Japanese).

Light-water reactors, including PWR and BWR, for electrical power generation, have experienced ups and downs in the past 10 years. The recent state is rather in the "downs", because of the extended construction period, the rise in power cost, the delay in reactor-plant delivery, etc. After reviewing the situation in the United States, the following are described. (1) The trend of technological development in light-water reactors. After improvement in many respects, the economy of light-water reactors is fairly established. Emphasis is now placed on the safety aspect. The PWR and BWR in this connection are described, including containment vessels, etc. (2) Problems in the power generation with light-water reactors, dealing with the preparation of criteria and codes, the power-distribution network, and so on. (Japan)

23238 DIRECTION OF THE DEVELOPMENT OF POWER REACTORS. GAS-COOLED REACTORS. Sakai, Masatoshi (Electric Power Development Co. Ltd., Tokyo). Genshiryoku Kogyo; 16: No. 4, 32-6(Apr 1970). (In Japanese).

Nuclear power generation is now in the practical stage. Aside from fast breeders, these reactors can be grouped in the light-water, heavy-water and gas types. In foreseeing the future of the respective types, it is necessary to consider their characteristics and development history. The following are reviewed, concerning the gas reactors: characteristics of gas reactors dealing with merits and demerits of the gas cooling; history of the development of gas-cooled reactors, including the first, second and third stages, i.e., the Magnox, AGR and HTGR types, respectively; AGRs, dealing with the high-quality steam, PCPV, etc.; HTGR, dealing with its peculiar fuel, multi-purpose application, etc.; relation between AGR and HTGR, explaining the common features, etc.; and gas-cooled fast breeder reactors. (Japan)

XUM

23239 DIRECTION OF THE DEVELOPMENT OF POWER REACTORS. ADVANCED THERMAL REACTOR. Unoki, Takeo (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 16: No. 4, 37-41(Apr 1970). (In Japanese).

An evaluation "check and review" was made on the propriety of development of the particular type ATR in Japan. It was confirmed subsequently, and construction started on the prototype, D_2O moderated and light-water cooled, in 1970. Based on the results of the check and review, the following are described: significance of the development of ATRs, dealing with the efficient utilization of nuclear fuel as intermediate before fast breeder reactors; the world state of ATRs development, in the U. S., Canada, the U. K., France, Germany, etc.; development of the ATR in Japan, describing its background and the national structure; and the development of an ATR, dealing with the maker and user, the competition-cooperation in technological development, versatility in fuel cycle, and the supply of heavy water. (Japan)

23240 DIRECTION OF THE DEVELOPMENT OF POWER REACTORS. FAST BREEDER REACTORS. Oyama, Akira (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 16: No. 4, 42-6(Apr 1970). (In Japanese).

The development of a fast breeder reactor, together with an advanced thermal reactor, in Japan was decided for the purpose of stabilized supply of nuclear fuel and advancement of the associated technology; the nucleus of its development is Power Reactor and Nuclear Fuel Development Corporation. The criticality planned for the experimental and the prototype reactor are in 1972 and 1976, respectively. Main features of the experimental reactor are the output of 50 MW(t), cooling by Na, fueled by mixed UO_2-PuO_2 with a blanket of depleted UO_2, and the breeding ratio of 1.01. Then those of the prototype reactor are the output of 750 MW(t), the cooling, fuel and blanket similar to the experimental reactor, and the breeding ratio of over 1.2. The experimental and prototype fast breeder reactors being developed in Japan are described in the course taken thus far and in the future program. (Japan)

23241 COURSE TAKEN IN THE DEVELOPMENT OF ATOMIC ENERGY, AND THE PROBLEMS. Yamada, Tasaburo (Atomic Energy Commission, Tokyo). Genshiryoku Kogyo; 16: No. 4, 9-12(Apr 1970). (In Japanese).

Research and development on atomic energy in Japan are proceeding according to the long-range program set in 1967, including the power reactors development by PNC. Notwithstanding, some variation has occurred the meantime, such as the advent of desalination and nuclear iron-manufacture. Up and down in the atomic energy mood are also fairly common. The present state, and prospects especially in the 1970s, and the problems, in Japan and oversea countries, are reviewed: nuclear power generation in Japan and the Unites States; development of power reactors, including ATR and FBR in Japan; other breeder reactors such as Na-cooled and gas-cooled reactors; high-temperature gas cooled reactors etc., and multipurpose applications; nuclear-powered ships, describing also container-shipment vessels; nuclear fuels, including overseas uranium-mine development etc.; and nuclear fusion reactions. (Japan)

23242 RESEARCH ON WATER COOLED REACTORS. Summary of the Activities of RCN and Industry. Texts of Addresses at a Conference of the Nederlands Atoomforum Held at Bunnik, Netherlands, 16–17 January 1968. Pelser, J.; Muysken, M.; van der Laken, R. A.; (and others). RCN (Reactor Cent. Ned.) Meded.; No. 32, 1-188(1969). (In Dutch). (CONF-680123).

Activities of the Reactor Centrum Nederland and industrial organizations in The Netherlands on the design, development, and testing of water cooled reactors for power production and ship propulsion are summarized. Texts of papers presented at a conference of the Nederlands Atoomforum held at Bunnik on January 16 and 17, 1968, are included. Titles of the papers are: Future of Water Cooled Reactors for Electricity Production; Research Program on Water Cooled Reactors of the RCN; Technological Research by the RCN; Reactor Physics Research for the NERO Design; Materials Research for the NERO Ship Reactor Project; Research on a Scale Model of the NERO Steam Generator; Research on Stresses in the Housing of a Heat Exchanger; and Research on a Control Rod Drive Mechanism for a Pressurized-Water Ship Reactor. (H.D.R.)

23243 HALF-TIME OF THE THIRD ATOM PROGRAM AT BRD. LEVEL AND TENDENCIES OF NUCLEAR RESEARCH AND DEVELOPMENT. Schuster, G. (Bundesministerium fuer Bildung and Wissenschaft, Bonn). Atomwirt., Atomtech.; 16: 34-42(Jan 1971). (In German).

The Third Atom Program of West Germany, which concerns government support of nuclear research and development, started in 1968. The five-year program has now reached its half-time. Discussed are differences between original projections and present status; program changes and their reasons; estimates and actually encountered costs. The following conclusions are reached: the projected cost of the total program will be exceeded by approximately 350 millions DM; cost of research and development will proceed almost as planned at governmental research centers; costs for research and development outside of these centers will exceed projected values because of the strong support needed by low energy physics, cyclotrons, and linear accelerators; costs of reactor development will be lower than projected; fuel cycle studies will require more money than planned because of ultracentrifuge and fuel element studies; and the costs of health physics will exceed the projected level. (H.B.G.)

23244 GENERAL ASPECTS OF THE FAST LATTICE. Vilain, J. Neue Tech., B; 10: 247-58(1968). (In French).

The general characteristics of fast reactors are summarized, and the advantages of these reactor types are tabulated. The reasons for the development of fast reactors in the U. S., USSR, Great Britain, and France are considered. The neutron, heat conductivity, and fuel and fuel element characteristics of fast reactors are discussed. (J.S.R.)

23245 FAST AND/OR THERMAL BREEDERS. DEVELOPMENT OF A THERMAL BREEDER REACTOR WITH LIQUID FUELS IN NETHERLANDS. Went, J. J.; Hermans, M. E. A. (Kernforschungszentrum, Karlsruhe, Ger.). Energ. Nucl. (Paris); 12: 533-43(Nov-Dec 1970). (In French).

Breeder or near breeder reactors are important in future large scale energy production. The advantages of thermal breeder reactors with liquid fuels and the possibilities of using aqueous suspension with them are discussed. These reactors are technically compared to fast breeders, but considered economically with light water reactors. In order to develop such a reactor system and to construct a small test reactor (the Kema suspension test reactor), reactor physics, fuel production, fuel behavior and system technology were considered. The most important results are presented. (auth) (France)

23246 JOINT RESEARCH CENTER IN PETTEN. Energ. Nucl. (Paris); 12: 529-32(Nov-Dec 1970). (In French).

The main units of the Joint Research Center in Petten are in the materials testing reactor HFR and the nuclear materials laboratory. The activities of the Petten research center consist of: the study of nuclear materials and the quality testing and checking of nuclear fuel components. In recent years, gas cooled high temperature reactors have become of particular interest. The construction materials and fuels used with this type of reactor are discussed. (auth) (France)

23247 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Benzler, Hartwig. British Patent 1,222,718. 17 Feb 1971. Filed 18 Oct 1968.

A fast gas-cooled nuclear reactor is described comprising a plurality of flat plate shaped fuel elements each including ceramic fuel and a metallic casing. The elements are at different spacings and the ceramic fuel is of different thicknesses for efficient heat removal. These spacings and thicknesses are such that under conditions of full load throughout the reactor the inner parts of the fuel at the same temperature and the fuel casings are also. Configurations of fuel elements in outer casings and the type of outer casing is specified. The advantages of running such a reactor system under suction through a duct system such that each fuel element is maintained at a pressure below that of the reactor cooling system are given. (UK)

23248 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Walton, Gilbert Northcott. (to United Kingdom Atomic Energy Authority). British Patent 1,222,824. 17 Feb 1971. Filed 1 May 1967.

A nuclear reactor is described comprising a nuclear fuel core, coolant moderator means operable on the core to extract heat from the core and to vary the reactivity of the core between a maximum and minimum value, and means to increase the amount of coolant moderator means applied to the core as the temperature of the core decreases and to decrease the amount of coolant moderator means applied to the core as the temperature of the core increases such that the reactivity and temperature of the core undergo a sustained self excited oscillation. The coolant moderator can be associated with a gaseous fluid which operates as a coolant, for example helium. The movement of the coolant moderator into and out of the core can produce an electrical current. This moderator could be liquid metal and then the movement through a magnetohydrodynamic converter could produce an electrical current. These movements of the coolant could also produce either mechanical movement or drive for a hydraulic motor. (UK)

XUM

23249 ENERGY GENERATING SYSTEMS. Coast, Geoffrey; Prince, Kenneth; Spruce, Brian; Morgan, Vernon. (to United Kingdom Atomic Energy Authority). British Patent 1,222,966. 17 Feb 1971. Filed 2 May 1967.

An energy generating system is described comprising a nuclear reactor and a heat energy-to-mechanical energy converter housed within a prestressed concrete pressure vessel and arranged for heat energy from the reactor to be conveyed directly to the converter by the reactor element, the components of the system, including the converter, being generally disposed in elongate cavities within the wall of the pressure vessel the cavities being spaced apart to define partition walls and the components being accessible from outside the pressure vessel, fluid flow ducts interconnecting the components being defined by penetrations in the wall of the vessel, by openings through the partition walls and by spaces between components and cavity walls. Details of the components of the system are given including the use of a plurality of subcircuits in the coolant circuit, each subcircuit receiving coolant from, and feeding coolant to, the reactor and including a gas turbine with electrical generator, a feed heater, a pre-cooler, a compressor and a second turbine. (UK)

Kinetics and Dynamics

Refer also to abstracts 22949, 23028, and 23392.

23250 (AI-AEC-12985) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, October–December 1970. (Atomics International, Canoga Park, Calif.). 15 Feb 1971. Contract AT(04-3)-701. 39p. Dep. NTIS.

CRITICAL ASSEMBLIES—Doppler coefficients for ECEL, ZPR-3, ZPR-6, and ZPR-9, (E/T)
—fuel element assemblies for ECEL Core 20
—physics calculations for fast, development of VIM computer program for
—reactivity worth measurements in ZEBRA and ZPR-3, (E/T)
LIQUID METAL FAST BREEDER REACTOR—physics measurement programs during October to December 1970
NEUTRON CROSS SECTIONS—calculation of fast critical assemblies, computer programs, (E/T)
REACTOR CONTROL ELEMENTS—reactivity with measurements for tantalum, in fast reactor spectra, (E/T)
REACTORS, FAST—physics calculations for, development of VIM computer program for
TANTALUM ISOTOPES Ta-181—neutron cross sections for, (T) (D.C.C.)

23251 (BARC/I-58) STATUS OF THE PHYSICS OF FAST REACTORS. Singh, R. S.; Rastogi, B. P. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 16p. NTIS (U. S. Sales Only).

A survey is made of the status of the physics of fast reactors. The main areas of physics development are broadly divided into five groups, namely, nuclear data, theory and computational methods, integral experiments and analysis, reactivity coefficients, performance studies and fuel cycles. The overall aim is to predict the various design parameters of a reactor such as criticality, power production, breeding or conversion, reactivity effects, dynamic characteristics, control rod worths and performance of shields, as accurately as possible. A coordinated effort among the five disciplines mentioned above is made to achieve the objectives. The individual problems to be tackled in these areas have been discussed. (INIS)

23252 (CEA-N-1378) DULCINEE CODE. Dutraive, Pierre; Fabrega, Samuel; Millot, Francoise (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Nov 1970. 69p. (In French). Dep. NTIS (U. S. Sales Only).

The DULCINEE Code is elaborated in order to study the behavior of a water cooled reactor at low pressure, either in steady state conditions or in transient ones during a reactivity accident or a loss of coolant accident. (auth) (France)

23253 (HEDL-SA-163) PROGRESS IN MEETING CROSS SECTION NEEDS FROM A FAST-REACTOR DESIGNER'S VIEW. Little, W. W.; Hardie, R. W.; O'Dell, L. D. (Hanford Engineering Development Lab., Richland, Wash.). [1970]. Contract AT-(45-1)-2170. 14p. (CONF-710301-1). Dep. NTIS.

From 3rd Conference on Neutron Cross Sections and Technology, Knoxville, Tenn.

An outline is given of the cross section requirements for the design and operation of fast breeder reactors. Progress toward meeting these requirements is then assessed by comparing calculated and experimental results from recent plutonium fueled fast critical assemblies. Finally, the results of selected sensitivity studies are given to permit the demands on integral reactor quantities to be translated into demands on individual cross sections. 11 references. (auth)

23254 (JPRS-52290) STUDIES IN PHYSICS AND POWER ENGINEERING. Translation of Eight Monographs of the Obninsk Institute of Physics and Power Engineering. 141p. NTIS.

Eight monographs dealing with the physics characteristics of fast reactors are presented. A separate abstract was prepared for each of the 8 papers. (H.D.R.)

For abstracts of individual papers see: 22949, 23028, 23029, 23255, and 23336–23339.

23255 (JPRS-52290, pp 1-24) CALCULATED VALUES OF THE CHARACTERISTICS OF FAST POWER REACTORS AS FUNCTIONS OF VARIATIONS OF THE CONSTANTS USED IN THE CALCULATION AND REQUIREMENTS FOR ACCURACY OF THESE CONSTANTS. Zaritskii, S. M.; Troyanov, M. F. Translated from Studies in Physics and Power Engineering. (CONF-691131-1).

From Symposium on Problems of Fast Reactor Physics, Melekess, USSR.

Methods of the theory of perturbations are used to produce data characterizing the sensitivity of the calculated values of critical parameters and breeding factors of fast power reactors to changes in the constants used in calculation. Reactors are studied with metallic, carbide and oxide plutonium fuel with core volumes of 2.5 m^3 and 5 m^3. A method is discussed for estimating the error in constants which can be considered permissible from the point of view of required accuracy of reactor design. Concrete estimates are made of the accuracy required for σ_c, α_f and ν_f of ^{238}U and ^{239}Pu in order to provide acceptable accuracy of the calculation of the characteristics listed above. (7 references) (auth)

23256 (KFKI-70-33-RPT) HECTIC-II: COMPUTER PROGRAM FOR HEAT TRANSFER ANALYSIS OF GAS OR LIQUID COOLED REACTORS. Kovacs, L. M. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 30 Nov 1970. 16p. Dep. NTIS (U. S. Sales Only).

The HECTIC-2 code developed for an IBM 7090 computer is adapted to ICL-1905 computers in FORTRAN language. HECTIC-2 calculates the pressure drop along the coolant channels, axial flow rates, heat transfer rates, and rod surface and coolant temperatures in gas-cooled or single-phase liquid-cooled reactors. (15 references) (auth)

23257 (KFKI-70-34-RPT) HOTRAN: STEADY-STATE AND TRANSIENT THERMOHYDRAULIC CALCULATIONS OF WATER-COOLED REACTOR CORES. Szabados, L.; Grillo, P.; Stuka, K.; Torok, A. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 20 Nov 1970. 10p. Dep. NTIS (U. S. Sales Only).

HOTRAN is a digital computer program for ICL-1905 computers in FORTRAN language. The code considers an open-lattice reactor core and calculates single- and two-phase coolant enthalpy, density, steam quality, temperature and mass flow-rate as functions of time and space coordinates. Mixing is taken into account, and the boiling crisis is also included. The program is a revised and modified version of the Westinghouse CAT and HYTRAN codes. (5 references) (auth)

23258 (RPI-328-217) IMPROVEMENTS TO SLOWING DOWN THEORY FOR FAST REACTORS. Dunn, Floyd E.; Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). 1970. Contract AT(30-1)-328. 62p. Dep. NTIS.

Continuous slowing down theory has proved to be useful in problems associated with thermal reactors. There are, however, two principal problem areas which inhibit obtaining the full benefits of continuous slowing down models in fast reactor problems. One problem area is the treatment of inelastic scattering. The second problem area is the treatment of scattering and absorption resonances in a mixture of several moderating materials. New methods are advanced for each of these problem areas. These methods are shown to lead to a continuous slowing down model of reasonable accuracy for fast reactor problems. The inelastic treatment is based on matching the solution for an easily solvable reference problem (the zero absorption case). The mixture treatments (several are considered) are based on averaging procedures over a scattering interval instead of at a single energy. 21 references. (auth)

23259 (TRG-Report-2118) NEUTRON SPECTRA FOR RUN 59/1 OF THE DOUNREAY FAST REACTOR. Crowe, D. S. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Dec 1970. 34p. Dep. NTIS (U. S. Sales Only). UK 25p.

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Tabulated total and group fluxes were calculated for the reactor loading as it was for Sectors B to F in Run 59/1. These results may be used for similar reactor loadings since Run 59/1 but should not be used for Sector A which has five rows of nickel instead of the normal three rows in the reflector. (auth) (UK)

23260 DYNAMICS OF A TWO-CIRCUIT INSTALLATION WITH A SELF-REGULATING REACTOR AND NATURAL CIRCULATION OF THE HEAT CARRIER. Orekhov, Yu. I.; Sidorova, I. I.; Kuz'menko, B. A.; (and others). This paper was summarized in At. Energ. (USSR); 26: 445-6(May 1969) as paper No. 284/5139. (In Russian).

The problem of determining the dynamic characteristics of a two-circuit steam-producing installation is presented together with some typical results. The installation has the following characteristics: a reactor of the water-cooled water-moderated type operates in the self-regulating mode; the circulation of the heat carrier in the first and second circuits is natural; saturated steam of variable parameters is fed to the turbine; the steam generator is built into the reactor vessel. An installation of this type is intended for a 1.5-MW atomic power station. (auth)

23261 TEMPERATURE FIELDS OF FUEL ELEMENTS IN THE BOR REACTOR CORE. Subbotin, V. I.; Ushakov, P. A.; Zhukov, A. V.; Sviridenko, E. Ya. This paper was summarized in At. Energ. (USSR); 28: 489-90(Jun 1970) as paper No. 390 /5349. (In Russian).

The temperature fields and the heat transfer in the assembly simulator for the BOR experimental fast reactor were investigated using smooth and ribbed mock-ups of fuel elements with and without displacers in the peripheral cells. The simulator consisted of a hexagonal shell containing 37 elements (fuel element mock-ups) in a checkerboard lattice. The energy release along the height of the simulator was constant. The highest temperature nonuniformity of the side elements was observed in the simulator with smooth elements without displacers. If displacers are installed in the peripheral cells, the temperature nonuniformity is reduced; the temperature fields assume a more filled-in aspect. The nonuniformities are still further reduced if spacing wire is wound on the elements. The maximum temperature nonuniformity as a function of different Peclet numbers is described. (auth)

23262 SIMPLIFIED, COARSE-MESH, THREE-DIMENSIONAL DIFFUSION SCHEME FOR CALCULATING THE GROSS POWER DISTRIBUTION IN A BOILING WATER REACTOR. Boerresen, S. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng.; 44: 37-43(Apr 1971).

A simplified, finite-difference diffusion scheme for a three-dimensional calculation of the gross power distribution in the core of a boiling water reactor (BWR) is presented. Results obtained in a series of one- and two-dimensional test cases indicate that this method may be of sufficient accuracy and simplicity for implementation in BWR-simulator computer programs. Computer requirements are very modest; thus, only 3N memory locations are required for in-core treatment of the inner iteration in the solution of a problem with N mesh points. The mesh width may be chosen equal to the fuel assembly pitch. Input data are in the form of conventional 2-group diffusion parameters. It is concluded that the method presented has definite advantages in comparison with the nodal coupling method. (auth)

23263 SOLUTIONS OF THE DIFFUSION EQUATION BY THE SPECTRAL-SYNTHESIS METHOD. Lorenzini, Paul G. (Atomics International, Canoga Park, Calif.); Robinson, Alan H. Nucl. Sci. Eng.; 44: 27-36(Apr 1971).

The spectral-synthesis method is investigated to assess its applicability for solving the diffusion equation in fast reactor design. The equations are derived so they may be solved by a standard diffusion theory code that allows upscattering. A reference 1000-MW(e) fast reactor is studied and two-dimensional solutions are obtained. The problem of selecting trial functions is examined and four different sets are used in the calculations. The results are compared with few-group calculations to test both accuracy and running times. The few-group and synthesis approximations are, in turn, compared with a 26-group solution which is treated as an exact solution. Some numerical instabilities are experienced and examined. It is concluded that the instabilities are caused by a complete coupling between equations in the scattering matrix. The accuracy of the synthesis approximation is comparable with the few-group approximation for calculating eigenvalues and is slightly superior for determining the flux in the core. 17 references. (auth)

Control Systems

23264 (UJV-2497-R) DATA LOGGERS AND THEIR USE IN NUCLEAR POWER ENGINEERING. Stulik, P.; Krejci, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [1970]. 52p. (In Czech). Dep. NTIS (U. S. Sales Only).

Problems of the use of data loggers in nuclear power engineering are discussed. On the basis of a survey of data loggers and acquired knowledge from operation of some these devices in Czechoslovakia, some parameters (i.e. range, equipment and type) of data loggers are given. (21 references) (auth)

23265 NUCLEAR REACTOR CORE AND CONTROL ELEMENT ARRANGEMENT. (to Combustion Engineering Inc.). British Patent 1,222,836. 17 Feb 1971. Priority date 14 Apr 1967, United States.

REACTOR CONTROL ELEMENTS—design of multiple pin type, for insertion in fuel pin assemblies
REACTORS, POWER—core configuration for, with control pins arranged in fuel pin assemblies (H.D.R.)

23266 NUCLEAR REACTOR CONTROL ELEMENT DRIVE ASSEMBLY. (to Combustion Engineering, Inc.). British Patent 1,223,277. 24 Feb 1971. Priority date 10 Oct 1967, United States.

REACTOR CONTROL ELEMENTS—drives for pressurized water reactor, description of rack and pinion
REACTORS, PRESSURIZED-WATER—control rod drives for, description of rack and pinion (D.C.C.)

23267 NUCLEAR REACTOR. Eich, Walter J.; Minton, George H.; Andrews, Harry N.; French, Robert J. (to Westinghouse Electric Corp.). U. S. Patent 3,551,289. 29 Dec 1970. Filed 24 Jan 1968.

A nuclear reactor is described wherein a plurality of two-position control elements capable of producing localized or fine flux trim (FFT) are commingled with the fuel rods in such a manner as to substantially control the reactivity and power distribution of its core region at power and to supplement the principal control elements which are incrementally movable neutron absorber rods. (auth)

Cooling Systems

Refer also to abstracts 20963, 21000, 21078, and 21464.

23268 (SAN-781-223) A STUDY OF HEATING AND INSULATION METHODS FOR LMFBR SODIUM PIPING. (Braun (C. F.) and Co., Alhambra, Calif.). 28 Feb 1969. Contract AT(04-3)-781. 40p. (CFB-4122-223). Dep. NTIS.

Heating and thermal insulating requirements for liquid Na piping are described. Results of a study of heating methods are summarized. Advantages and disadvantages of various methods are evaluated. (D.C.C.)

23269 (SAN-781-231) A STUDY OF LMFBR SYSTEM INTERFACES. (Braun (C. F.) and Co., Alhambra, Calif.). 28 Mar 1969. Contract AT(04-3)-781. 37p. (CFB-4122-231). Dep. NTIS.

The degrees of constraint imposed on the piping by the system interfaces are analyzed. Design parameters are presented for the interfaces. The equipment interface, the in-line component interface, the fluid interface, and the LMFBR program interfaces are discussed. 12 references. (auth)

23270 (UJV-2390-RT) RADIATION EFFECTS ON MECHANICAL PROPERTIES OF CONCRETE. Stoces, B.; Otopal, P.; Juricka, V.; Gabriel, J. (Ceskoslovesnka Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Oct 1970. 63p. (In Czech). Dep. NTIS (U. S. Sales Only).

In the frame of a design study of a HWGR power reactor for a 500 MW power plant a prestressed concrete pressure vessel has been studied. The type of concrete for the pressure vessel is studied for the neutron radiation effects during the plant life. Irradiation of series of concrete patterns and detailed measurements show that changes of mechanical properties of the patterns for doses up to $3 \cdot 10^{18}$ n/cm^2 for neutrons of E > 1 MeV are negligible. 10 references. (auth)

23271 (UNC-5234) A STUDY OF INSTABILITY ANALYSIS METHODS AS RELATED TO LMFBR PIPING SYSTEMS. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center. Braun (C. F.) and Co., Alhambra, Calif.). 13 Feb 1969. Contract AT(04-3)-781. 93p. (SAN-781-240; CFB-4122-240). Dep. NTIS.

A basis for the development of instability design criteria for thin-wall large diameter piping systems for LMFBR is presented. Existing instability analysis methods, related computer programs, and experiments of a piping system under arbitrary loading, con-

sisting of cylindrical tubes and local components such as elbows, returns, tubular connections, rod for hangers and supports, are reviewed. 119 references. (auth)

23272 (WAPD-TM-1000(Vol.1)) HEAT TRANSFER AND FLUID FLOW WITH APPLICATIONS TO PRESSURIZED WATER REACTORS. VOLUME I. CHAPTER 1. INTRODUCTION. CHAPTER 2. HEAT CONDUCTION IN SOLIDS. Pfennigwerth, P. L.; Minkler, Bill (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan 1971. Contract AT-11-1-GEN-14. 209p. Dep. NTIS.

For the student of Nuclear Reactor Heat Transfer and Fluid Flow, the subject's important concepts and laws are developed and applied with emphasis on their essential unity and drama. Vectors and other mathematical tools are used extensively, but are developed as needed, with focus always on what's happening physically. The text is liberally illustrated, and leavened with occasional gentle humor to make the rough places plain. Topics covered are: Basic Mathematical and Physical Concepts; Heat Conduction in Solids; Fluid Dynamics; Heat Transfer in Fluids; Two-phase Heat Transfer and Fluid Flow; Heat Transfer by Radiation. (auth)

23273 STUDY ON COOLANT MIXING IN MULTIROD BUNDLE SUBCHANNELS. Cha, Jong Hee; Cho, Moon Haeng (Atomic Energy Research Inst., Seoul). J. Korean Nucl. Soc.; 2: No. 1, 19-25(Mar 1970).

A study was conducted on the coolant mixing between water flowing in two adjacent subchannels. Measurements were made of the quantity of mass transferred between a larger rectangular channel and a smaller triangular channel in a 19-rod fuel bundle under the conditions of single phase flow and air-water two-phase flow. The results of the experiments showed that the low mixing rate appears in single phase flow, and high mixing rate was measured in air-water two-phase flow. Mixing rate decreases with the increasing of air void fraction during the air-water flow. It seems that the high mixing rate in the air-water flow was caused due to adequate agitation of the chaotic air void. 7 references. (auth)

23274 APPARATUS AND METHOD FOR AUTOMATIC MUTUAL ADJUSTMENT OF THE COOLANT AND MODERATOR PRESSURES OF A NUCLEAR REACTOR. Tonarelli, Lorenzo (to Sulzer Brothers, Ltd.). U. S. Patent 3,560,337. 2 Feb 1971. Priority date 26 Oct 1967, Switzerland.

A leveling vessel is disposed outside the moderator vessel and is connected to both the moderator circuit in the moderator vessel and to at least one point in the coolant gas circuit. The pressures of the coolant and moderator are compared within the leveling vessel without using any other barrier medium. Branch pipes are provided off the lines to the leveling vessel to permit purification and return of the coolant and moderator to their respective circuits. (auth)

23275 GAS-COOLED NUCLEAR REACTORS. Brown, Gordon (to Atomic Power Constructions Ltd.). U. S. Patent 3,560,338. 2 Feb 1971. Filed 9 Feb 1968.

A nuclear reactor having a core entirely surrounded by a gas tight partition is described. The partition is located within and completely separated from a pressure vessel. The core is supported upon a lattice supporting structure, which contains a plenum chamber. Heat exchangers are situated between the partition and the pressure vessel. Coolant gas is circulated from the plenum chamber up through fuel channels in the core down through the heat exchangers, part of the coolant flowing directly into the plenum chamber to join the remainder which passes up the side of the core and down through passageways in the core to the plenum chamber. (auth)

23276 ACTIVATION OF CORROSION PRODUCTS IN THE PRIMARY LOOP OF A PRESSURIZED-WATER REACTOR. Kasperovich, A. I.; Bychkov, N. V. This paper was summarized in At. Energ. (USSR); 28: 490-1(Jun 1970) as paper No. 392/5456. (In Russian).

The process of buildup of radioactive isotopes, as corrosion products, in the primary loop of a pressurized-water nuclear reactor was investigated theoretically. It was assumed that the principal sources of this activity are: activation of corrosion deposits on the surfaces of the reactor core and corrosion of activated structural materials of the reactor. The contribution made by the activity formed through activation of corrosion products in the water circulating through the reactor core is negligible; the amount of activity carried off by the bypass purging system is likewise discountable. With these assumptions in mind, a differential equation was derived to describe activation of corrosion products in the primary loop of the reactor. The formula obtained is valid for calculating activity buildup (in terms of isotopes ^{51}Cr, ^{59}Fe, ^{60}Co) in a stainless steel loop. (auth)

23277 PRESSURE VESSEL ENGINEERING TECHNOLOGY. Nichols, R. W. (ed.). London; Elsevier Publishing Company, Ltd. (1971). 620p. £ 14.

Chapter 9 B of the book is entitled, the Nuclear Reactor Pressure Vessel and the Problem of Irradiation Embrittlement. The following subjects are discussed; the nature of irradiation damage, the effects on mechanical properties, effect of irradiation variables on embrittlement (neutron dose or fluence, irradiation temperatures, neutron spectrum, neutron flux, effect of testing method, effect of material variables, effect of stress and strain), property surveillance (damage monitoring), discussion of engineering implications. (UK)

23278 INVESTIGATIONS FOR THE DESIGN OF HEXAGONAL CORE CHANNELS IN STEAM-COOLED REACTORS. Eisner, J. H. Konstr. Masch.-, App.- Geraetebau; 22: 208-10(1970). (In German).

The essential criteria for the mechanical properties of hexagonal channels in steam-cooled reactors are discussed. The correlation between external pressure, wall thickness, stress and deformation is investigated and terms of maximum stress and deformation are given. (INIS)

23279 ELECTROMAGNETIC PUMP AND ELECTROMAGNETIC FLOW METER FOR A SODIUM COOLED FAST REACTOR. Akiyama, Shigeru; Yada, Hisashi (Fuji Electric Co. Ltd., Tokyo). FAPIG (Tokyo); No. 55, 193-9(Dec 1969). (In Japanese).

As part of the development of a Na-cooled fast reactor, electromagnetic pumps have been developed and also electromagnetic flow meters. Faraday-type electromagnetic pumps constructed in trial, to be installed in a fast reactor facility, include those of Na main circulation and Na refining, etc. One outstanding feature of the pumps is the embodiment of Na duct and electrodes, thereby eliminating the usual difficulty in electrical contact at the electrodes. Its life and reliability are fairly high. An electromagnetic Na flow-meter has many advantages, including a highly linear indication and simple construction. It also differs largely from the same type for conventional uses. The ones constructed in trial are described. (Japan)

23280 PHYSICAL BASIS FOR TWO-PHASE PRESSURE GRADIENT AND CRITICAL FLOW CALCULATIONS. Tremblay, P. E.; Andrews, D. G. (Univ. of Toronto). Nucl. Sci. Eng.; 44: 1-11(Apr 1971).

From the basic conservation equations in two-phase hydrodynamics, an expression for the pressure gradient was derived. A key quantity in the denominator of that expression is recognized as the ratio of the actual-to-sonic two-phase mass fluxes. This dimensionless ratio is seen as a generalization of the Mach number. The expression for the sonic mass flux is shown to be an equation-of-state depending only on local properties of the fluid. The conditions that make the dimensionless ratio equal to 1 are shown to correspond to the critical conditions. 29 references. (auth)

23281 CRITICAL HEAT FLOW IN BOILING NUCLEAR REACTORS. Haiduc, C.; Vinitchi, V. Stud. Cercet. Energ. Electroteh.; 20: 541-53(1970). (In Rumanian).

The outcome of research work carried out with a view to measuring the critical heat flows and heat transfer in water boiling for one cylindrical nuclear fuel cell in natural circulation conditions is presented. The influence of the inclination angle of the cell on heat transfer and hysteresis phenomenon at boiling temperature is measured. To determine the critical flow, a new criterial equation was developed. The results derived thereby are compared to those reported by other authors and to the experimental findings. (auth) (Rom. Sci. Abstr.)

23282 TRENDS OF PRESTRESSED-CONCRETE PRESSURE VESSELS AND CONTAINMENT VESSESLS IN NUCLEAR POWER STATIONS. Nagakura, Tadashi (Central Research Inst. of Electric Power Industry, Chiba, Japan). Semento Kogyo; No. 106, 1-7(Sep 1970). (In Japanese).

Prestressed concrete (PC) pressure vessels originated in British gas-cooled reactors, while PC or RC (reinforced concrete) containment vessels are taking the place of steel vessels, especially in the United States. The present state, features, problems and future of the PC pressure and containment vessels are described as follows: (1) The trends of the PC vessels. The development of PC pressure vessels enabled the development of AGR, HTGR, etc. Recently the transition from steel to PC or RC containment vessels takes place in BWRs and PWRs. (2) Features of the PC vessels. The advantage of PC pressure vessels are abolition of concrete shield and increasing safety and cost reduction. The relation between the function of the PC containment vessels and design condition is explained. (3) Problems in the PC vessels. The problems are concrete quality,

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prestressing method, steel liner strength and cooling of concrete, etc. (4) New development in the PC pressure vessel. The wire winding technique to give circumferential prestressing, the pod-boiler system to place a heat exchanger in the containment vessel, and the PC pressure vessel for a D_2O, boiling light-water reactor are developed. (Japan)

Fuels

Refer also to abstracts 21298 and 23342.

23283 (ANL–7604) ORIGIN OF FISSION-PRODUCT RELEASES IN EBR-II, NOVEMBER 23, 1967–MAY 6, 1968. Smith, R. R.; Ebersole, E. R.; Fryer, R. M.; Henault, P. B. (Argonne National Lab., Ill.). Dec 1970. Contract W-31-109-eng-38. 41p. Dep. NTIS.

The second verified series of fission-product releases in EBR-II began on November 23, 1967. Results of analyses for ^{133}Xe and ^{135}Xe in the cover-gas system confirmed that the releases originated from fresh fuel material. Attempts to associate the releases with recently installed driver-fuel subassemblies were unsuccessful in view of a subsequent release on December 6, 1967. Eventually the releases were attributed to capsule BC02 in irradiation subassembly X028, capsule BC02 contained a prototypal fuel element of U–Pu–Zr ternary alloy. The results of postirradiation examinations on capsule BC02 revealed substantial fuel melting and rearrangement, particularly in the upper and lower regions. From these results and from observations of the various fission-product releases from capcule BC02, a physical model of the defect was generated; this postulated model was consistent with all available experimental information. 13 references. (auth)

23284 (BARC-I–48) CORE DESIGN ASPECTS OF FAST BREEDER REACTORS. Garg, S. B. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 23p. NTIS (U. S. Sales Only).

Some design aspects of the cores of fast breeder reactors are described. Safety, fuel cycle, control and stability features are discussed in relation to economics and core design. Design aspects of blankets are also included. Merits and demerits of steam and helium cooling are given. Very good breeder performance is anticipated with helium as coolant. It is pointed out that carbides hold a great promise for the fast expansion of nuclear power. (INIS)

23285 (NEDC–12152) PLUTONIUM UTILIZATION IN BOILING WATER REACTORS, PHASE II SEMIANNUAL REPORT, JANUARY–JUNE 1970. O'Neill, G. L. (comp.) (General Electric Co., San Jose, Calif. Reactor Fuels and Reprocessing Dept.). Sep 1970. 44p. Dep. NTIS.

For Edison Electric Inst., New York.

Big Rock Point irradiations and pool examinations for 32 PuO_2–UO_2 fuel rods, fabrication, installation, and initial irradiation in Big Rock Point for three PuO_2–UO_2 fuel bundles, and design and preliminary safeguards work for four Vermont Yankee PuO_2–UO_2 bundle prototypes are reported. Plutonium recycle design optimization and economic studies are discussed and an "interim reference design" selected for boiling water reactor recycle of plutonium. (auth)

23286 EXPERIMENTAL STUDIES WITH DSR TEST ELEMENTS FOLLOWING HIGH BURNUP. Garzarolli, F.; Moeller, U.; Trinkl, A.; Uhde, W. (AEG-Telefunken, Grosswelzheim, Ger.). Atomwirt., Atomtech.; 15: 587-90(Dec 1970). (In German).

Within the framework of fuel element development for steam-cooled breeder reactors, two arrangements were irradiated in the experimental loop of the pilot nuclear power station Kahl (VAK). The first consisted of a single fuel rod and the second one of a bundle comprising three rods with Inconel-625 cladding and vibrated UO_2 powder as fissionable material. The first one was irradiated close to burnup of 80,000 MWd/tU when rupture of the cladding occurred. The second arrangement was irradiated to a burnup of 36,000 MWd/tU. Following irradiation, the fuel elements were subjected to careful studies as to behavior of rods, fuel, and cladding. It was concluded that the fuel element was practically feasible up to a cladding temperature of 690°C and burnups of approximately 100,000 MWd/tU. The rupture of the first experimental arrangement was found to be caused by pre-existing defects and not by the experimental conditions. (H.B.G.)

23287 DIRECTION OF THE DEVELOPMENT ON A NUCLEAR FUEL CYCLE. PRODUCTION OF NUCLEAR FUELS. Taketani, Kiyoaki (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 4, 55-8(Apr 1970). (In Japanese).

The technology of metal nuclear fuels in Japan is nearly established after about 15 years of efforts, and the future problems are in improvement of the quality from experience. Then, concerning the fuels for light-water reactors, it is necessary to have their technology proven by the middle of the 1970s. The fuels for fast reactors and HTGRs are subject to uncertainties; however, in the first part of the 1970s considerable knowledge should be accumulated. Production of nuclear fuels is described in the following: metallic fuels, dealing with the development of metallic U and Al–U alloy fuels and the test of Magnox, natural-U fuel by monitoring in the power station; nuclear fuels for light-water power reactors, dealing with the domestic production of UO_2 fuels, and safety and economic aspects of the fuels; and fuels for the future, including fast reactors and HTGRs. (Japan)

23288 NUCLEAR FUEL ASSEMBLY. Crambes, Jean P.; Doare, Herve J. F.; Rosuel, Andre L. R.; Rouvillois, Xavier M. M. (to Societe Nationale d'Etude et de Construction de Moteurs d'Aviation). French Patent 1,593,737. 1 Jun 1970. Filed 28 Nov 1968. (In French).

A fuel assembly for a boiling water reactor is described. The assembly consists of an array of pencils of cladded fuel materials situated at the corners of a regular lattice (square in general), and it possesses structural elements and an array of spiraled bands whose axes are parallel to those of the pencils for the manipulation of the assembly block. Two adjacent bands have the same pitch but in opposite senses and are joined together at each half pitch. (auth) (France)

23289 CURRENT BWR FUEL DESIGN AND EXPERIENCE. Williamson, H. E.; Ditmore, Dana C. (General Electric Co., San Jose, Calif.). Reactor Technol.; 14: 68-98(Spring 1971).

An up-to-date review of experience and development data on boiling-water-reactor (BWR) Zircaloy-clad UO_2 fuel is presented. The area of technology demonstrated by irradiations of Zircaloy-clad UO_2 fuel rods and pins in reactors, loops, and capsules goes beyond the combination of fuel-rod power and exposure that will be experienced in modern BWRs not only for normal continuous operation but also for anticipated power transients. The recorded successful irradiations demonstrate that not only safe but reliable fuel can be designed for modern BWR conditions. A value of 1% plastic strain of Zircaloy cladding is defined as the limit below which fuel damage due to overstraining is not expected to occur during any single power transient. The linear heat-generation rate required to cause this amount of cladding strain is ~28 kW/ft in fresh fuel. The analytical and experimental bases employed in the justification of this limit are reviewed. 32 references. (auth)

23290 FUELS FOR HIGH-TEMPERATURE GAS-COOLED REACTORS. Yamamoto, Tatsuro; Hyodo, Ohiko (Furukawa Electric Co. Ltd., Tokyo). FAPIG (Tokyo); No. 55, 176-82(Dec 1969). (In Japanese).

Nuclear fuels for HTGRs differ from the conventional fuels; the advent of HTGRs is due to the remarkable success of the particular type of fuels employed. To produce the fuel, fuel spheres of about seven-hundred microns in diameter are coated with pyrolytic carbon or SiC, which are then contained in a sheath of low-permeability carbon; each sphere has the ability to retain fission products in it. The world state of nuclear fuels for HTGRs are reviewed, concerning the spherical fuel nuclei, coating layers, bonding, and fuel element. (Japan)

23291 FUEL ELEMENT. Marquet, Marc; Sermet, Eric (to Commissariat a l'Energie Atomique). French Patent 1,597,385. 22 Jun 1970. Filed 30 Dec 1968. (In French).

The invention concerns nuclear fuel elements, particularly those used in graphite gas reactors. The element contains a cylindrical rod of fissile material with finned metallic cladding. This element is mounted inside an annular graphite sheath which holds it in the coolant gas channel, usually vertical. This channel runs through the mass of graphite which acts as moderator of the neutrons produced by fission of the material. The centering devices are corrugated over part or all of their height. (auth) (France)

Auxiliary and Emergency Systems

Refer also to abstracts 23313 and 23331.

23292 (ANL/EBR–29) FUNCTIONAL DESCRIPTION OF THE EBR-II DIGITAL DATA ACQUISITION SYSTEM. Allen, J. M.; Hyndman, R. W.; Call, R. A.; Laird, E. W.; Tuck, M. R.; Tucker, K. D. (Argonne National Lab., Idaho Falls, Idaho). Nov 1970. Contract W-31-109-38. 39p. Dep. NTIS.

The EBR-II digital data acquisition system (DAS) is a Sigma 5 computer specifically configured to perform data acquisition

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and detailed on-line data reduction. The hardware description presented describes each of the major components and its interaction with the other system components. The description enables an understanding of the hardware, hardware interaction, and some of the considerations necessary for developing the system software. (auth)

23293 (ANL-EBR-33) DESCRIPTION OF SOFTWARE FOR THE EBR-II DIGITAL DATA ACQUISITION SYSTEM. Hyndman, R. W.; Allen, J. M.; Call, R. A.; Laird, E. W.; Tuck, M. R.; Tucker, K. D. (Argonne National Lab., Idaho Falls, Idaho). Dec 1970. Contract W-31-109-eng-38. 24p. Dep. NTIS.

System configuration, allocation, protection, and maintenance of software associated with the EBR-II digital data acquisition system are described. Software prepared both by Xerox Data Systems (the manufacturer of the Sigma 5 computer of the system) and by the EBR-II Project is considered. (auth)

23294 (CONF-700307-7) USE OF LEAD IN UNLOADING SYSTEMS OF SODIUM-COOLED FACILITIES. Shirin, V. M.; Karpov, A. V.; Aristarkhov, N. N.; Efimov, I. A.; Mamaev, L. I.; Milovidov, I. V. Translated from IAEA Symposium on Progress in Sodium-Cooled Fast Reactor Engineering, Monaco, March 23–27, 1970. 10p. Dep. NTIS.

Experiments on the use of lead in unloading systems for sodium-cooled facilities are described. Results are given of determinations of the effectiveness with which the assemblies removed from the sodium are washed with molten lead and of determinations of the quantity of sodium and lead remaining on the assembly surfaces after removal from the media in question. Findings on the effect of the lead on the leak-tightness of the fuel assemblies when stored in baskets with lead are presented. It is shown that lead does not cause a deterioration of the leak-tightness of the fuel elements in the assemblies. Results of studies on the escape through lead of gaseous fission products from fuel elements which are not leak-tight are given. It is shown that no gas escapes through solidified lead from failed fuel elements but that molten lead has virtually no restraining effect on the escape of active gas from fuel elements. (auth)

23295 DEVELOPMENT OF MAJOR COMPONENTS FOR FBR. THE DEVELOPMENT OF FUEL HANDLING SYSTEM. **Fujita, Mototsugu; Horita, Osamu (Fuji Electric Co. Ltd., Tokyo). Genshiryoku Kogyo; 16: No. 9, 35-9(Sep 1970). (In Japanese).**

The fuel handling system for a fast breeder reactor includes new and spent fuel storages and the fuel exchange itself; the latter presents most difficulties. The fuel exchange mechanism in connection with the Fast Breeder Reactor being developed in Japan is described. The fuel exchange device in a Na environment and at a high specific power (or burnup) presents special difficulties. Two procedures for fuel exchange are described: the rotating plug method in which an exchange apparatus is fixed to the lower side of the reactor top-plug, and in the hot-cell method, in which the plug is taken into the overhead space for fuel-handling in the core. Development of seals, bearings, Na-vapor, cooling, and mock-up tests are discussed. For the FBR being developed in Japan, the plug method of fuel exchange, with two rotations are employed. (Japan)

Operation and Economics

Refer also to abstracts 21303, 23377, and 23378.

23296 (GEAP-13599) FUMBLE: AN APPROACH TO FAST POWER REACTOR FUEL MANAGEMENT AND BURNUP CALCULATIONS. Greebler, P.; Cowan, C. L. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Nov 1970. Contract AT(04-3)-189. 516p. Dep. NTIS.

FUMBLE computes the fuel burnup in reactor operations. This includes the evaluation of reactivity effects, breeding (or depletion) and inventories of fuel, and fuel costs for changing economic conditions and supplied fuel compositions through the reactor lifetime (or for as many refueling operating intervals as desired). Fuel cost components associated with fabrication and reprocessing are computed by treating these operations in a "black box" manner, using input data parameters such as reprocessing time, fissile material losses, unit fabrication costs, etc. Considerable flexibility is allowed in the specifications of reactor refueling, including fuel compositions for the startup reactor, recycle schemes and fissile makeup compositions for subsequent core loadings, amounts of fuel to be replaced in different positions of the reactor at any refueling, and shuffling of fuel from one part of the reactor to another or temporarily storing fuel discharged from the reactor for later additional burnup. The refueling specifications may be changed from one refueling operating interval to another, as well as operating interval time, power rating, and load factor. Fuel costs may be evaluated for several different sets of cost input data 'different economic assumptions' and may be based on net costs accrued and energy produced by spent fuel batches and/or on net costs incurred for all fuel held and energy produced by the entire reactor for each operating interval. FUMBLE is written almost entirely in FORTRAN-IV for the GE 635 computer. (auth)

23297 (ORNL-TM-3271) CALCULATED NUCLEAR AND ECONOMIC PERFORMANCE OF NIOBIUM AND MOLYBDENUM IN LMFBR CORES. Bennett, L. L.; Thomas, W. E.; Homan, F. J. (Oak Ridge National Lab., Tenn.). 12 Feb 1971. Contract W-7405-eng-26. 41p. Dep. NTIS.

A study of the effect on LMFBR nuclear and economic performance resulting from use of niobium and molybdenum as cladding and/or fuel element structural materials is described. The work reported places primary emphasis on the economic aspects, especially the relative fabrication costs with different materials, and provides economic results needed for a complete evaluation of the relative merit of the selected refractory metals. 9 references. (auth)

23298 (UJV-2412.R,T.) THE RECAL PROGRAM. CALCULATION OF A CANDU-TYPE REACTOR. Kujal, B.; Kujal, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [nd]. 9p. (In Czech). NTIS (U. S. Sales Only).

A basic description of the RECAL program and its function is given, including information on the input and output quantities. The program was created by combining the codes for physics calculations of burn-up in a CANDU-type reactor with a program for calculating neutron flux flattening in the core, and with a thermotechnical calculation of a maximum load channel. The resulting program was used to compute some of the variants of a nuclear power station with a CANDU-type reactor with a net electrical output of 600 MW. The most important results of the computations are compared with data pertaining to the Canadian project. It follows from the comparison that the RECAL program meets requirements on a determination of fundamental reactor characteristics which are to be used in a preliminary design of a nuclear power station and in an assessment of its economic parameters. (INIS)

23299 STUDY OF THE OPTIMUM FUEL RELOADING PATTERN FOR 1,100 MW (e) PWR. **Yata, Minoru; Watanabe, Takao (Sumitomo Electric Industries Ltd., Osaka). Sumitomo Elec. Rev.; No. 102, 103-10(Sep 1970). (In Japanese).**

Several fuel reloading patterns were surveyed to determine the optimum pattern of refueling the 1,100 MW(e) PWR. The patterns of the fuel reloading studied were the 3 region out-in, the modified 3 region, the 4 region out-in, the Roundelay, the modified Roundelay, the scatter, and the modified scatter pattern. TRILUX-QC-2, the 3 dimensional nuclear-thermal and hydraulic coupled code, was used for all studies of reloading pattern. The determination of the optimum pattern was fixed, satisfying the following criteria: (1) The maximum burnup for a given feed enrichment is obtained. (2) The maximum radial power peaking factor must be smaller than 1.5. As a result, it was concluded that the modified scatter pattern was the best. (Japan)

23300 COST ANALYSIS OF NUCLEAR FUEL CYCLE. **Sakairi, Takehiko; Watanabe, Hiroshi (Chubu Electric Power Co. Inc., Nagoya, Japan). Chubu Denryoku K. K. Kenkyu Shiryo; No. 45, 83-95(May 1970). (In Japanese).**

In the cost analysis of nuclear power generation, nuclear fuel cycle is the most difficult problem. The development of the computer program for the analysis of fuel cycle is reported, in which the condition to be considered by an electric power company is taken into account sufficiently. The characteristics of this program are as follows: The limit of application was extended by the calculation of fuel exchanging interval, and the consumption of fuel in a reactor, hitherto given as input. The load factor and the unit cost of a plant was made changeable for every year, and many other things. The result of this analysis showed that the load factor of a plant had considerable influence upon cost, and that cost decreased with increasing burnup. Further, it was shown that the enrichment of waste uranium in an enrichment plant did not affect the total cost of fuel cycle cost, and that the extension of fuel fabrication period raised a little the total cost on account of increasing interest. (Japan)

23301 ACCUMULATION OF PLUTONIUM FOR THE DEVELOPMENT OF FAST REACTORS. **Kazachkovskii, O. D.; Kirillov, E. V. This paper was summarized in At. Energ. (USSR); 28: 418-19(May 1970) as paper No. 381/5538. (In Russian).**

A method for establishing the economic maximum possible (critical) time t_{CR} for storing plutonium before using it in fast

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reactors is presented. Under actual conditions the time from which it is practical to begin to accumulate plutonium may be earlier than the time fast reactors are put into operation by less than t_{CR}, and is determined by the ratio of the rates of delivery of plutonium from thermal reactors and its consumption in fast reactors. For several possible cases of this ratio equations are obtained for determining the time from which the accumulation of plutonium should begin and the time at which fast reactor-converters as well as fast reactor-multipliers should be put into operation to ensure a given rate of increase of fast reactors. Numerical calculations performed for a typical case show that the introduction of an additional amount of plutonium into a system of fast reactors in the initial stage of their development enables substantial amounts of ^{235}U to be saved later. (auth)

23302 NUCLEAR FUEL MANAGEMENT. Craig, T. W.; Brandfon, W. W. Power Eng.; 75: No. 2, 38-41(Feb 1971).

Three computer programs to analyze light water reactor fuel cycles are discussed. The POWER-P and POWER-B codes predict fuel performance in commercial reactor designs. The CINCAS code combines this performance data with projected economic data to evaluate the fuel cycle economics. (H.D.R.)

23303 SODIUM-COOLED REACTORS: CURRENT STATUS OF PLANT-SYSTEMS OPERATIONS. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol.; 14: 39-41(Spring 1971).

Preparations for restart of the Fermi Fast Breeder Reactor during the period January through June 1970 are summarized. (H.D.R.)

23304 ECONOMIC ASPECTS OF THE FUEL CYCLE FROM THE SWISS VIEWPOINT. Pekarek, H. J. (Elektro-Watt Ingenieurunternehmung AG, Zurich). Neue Tech., B; 11: 137-50(1969). (In German).

A brief review is given of the fuel cycle for reactors of the present generation. The economic aspects of the most important components of the fuel cycle are considered. These include a review of the present market and competition circumstances for materials and service circuits. The average-delay of power plants are evaluated from the viewpoint of the Swiss power consumption. The possibilities of the Swiss economy in the nuclear fuel sector are discussed. (J.S.R.)

Safety and Siting

23305 (BAW-10015) MULTINODE COMPUTER CODE ANALYSIS OF LOSS-OF-COOLANT ACCIDENT. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Feb 1971. 86p. Dep. NTIS.

The multinode evaluation of several loss of coolant accidents for 2568-MW(t) nuclear power plants with pre-pressurized fuel pins is presented. The basic computer code is discussed, including modifications that have been incorporated to make it more applicable to the system analyzed. Also, basic assumptions are listed, and areas of uncertainty and conservatism are discussed. The multinode model was used to perform a core cooling analysis for a spectrum of break sizes in the cold and hot legs of the reactor coolant system. Curves showing hot spot fuel cladding temperature versus time after an assumed break are included for a spectrum of hot and cold leg break sizes. 19 references. (auth)

23306 (BNWL-1470) HIGH-ENTHALPY-WATER BLOWDOWN TESTS FROM A SIMPLE VESSEL THROUGH A SIDE OUTLET. Allemann, R. T.; McElfresh, A. J.; Neuls, A. S.; Townsend, W. C.; Wilburn, N. P.; Witherspoon, M. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1971. Contract AT(45-1)-1830. 67p. Dep. NTIS.

Safety studies concerning the design basis loss-of-coolant accident of a water cooled nuclear power reactor were carried out with a 150 ft^3 reactor simulator vessel by performing tests of a blowdown through a 1.5 to 6.8 in. diameter orificed side nozzle. Liquid level and weight, vessel pressure and temperature, exit duct void fraction, and reaction thrust were measured during blowdown, and high speed movies were taken of the fluid in the exit duct. Comparisons were made with theory and with earlier results. Previous saturated flow rate results were confirmed, and a decrease in mass velocity with nozzle size was associated with increased void fraction. However, since no bubbles could be seen for large break sizes, it was inferred that the bubbles are extremely small (less than $\frac{1}{64}$ in. diameter). Liquid remaining in the vessel after blowdown was 2 to 6% of initial mass. 12 references. (auth)

23307 (BNWL-1475) LEAKAGE RATE TESTS ON THE CSE CONTAINMENT VESSEL WITH HEATED AIR AND STEAM-AIR ATMOSPHERES. Witherspoon, M. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1970. Contract AT(45-1)-1830. 69p. Dep. NTIS.

A series of ambient air, hot air and steam-air leakage tests were performed as a part of the Containment Systems Experiment program. Tests at three pressures were performed with room temperature air, heated air, and with saturated steam-air mixtures. Data were taken for calculating integrated vessel leakage rates by the absolute method and the reference vessel method. Leakage flow rates from individual leakage points were measured in all three atmospheres. Behavior of individual leak points and results of calculations and corrections are described. The vessel leakage rate decreased to less than half the cold air value during the initial heated air test at 170°F and 9 psig. The leakage rate decreased further with higher temperature and with steam-air atmospheres. (auth)

23308 (CONF-700816-(Vol.2), pp 817-23) MEASUREMENTS OF PARTICULATE FILTRATION EFFICIENCIES OF BUILDING. Nelson, C.; Granger, J.; Koontz, R.; Baurmash, L. (Atomics International, Canoga Park, Calif.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The release and transport of effluents generated during hypothetical major Liquid Metal Fast Breeder Reactor (LMFBR) accidents are being characterized for application to safety and engineering safeguards design, since the doses at the site boundaries are based on the leaked mass of hazardous materials. Experiments and results which show that the airborne mass is considerably reduced as it passes through concrete and other porous materials are described. Experiments indicate that as much as a 10^5 attenuation of sodium oxide aerosol can be expected as it passes through as little as $1\frac{1}{2}$ in. of concrete. Leakage through cracks and capillaries is evaluated experimentally, to show the role of impaction, settling, and diffusion in reducing the leaked mass. 3 references. (auth)

23309 (EUR-4592) THERMO-HYDRODYNAMIC MODEL FOR THE THEORETICAL STUDY OF THE BOILING AND EJECTION OF THE COOLANT FROM A REACTOR CHANNEL DUE TO A DIRECT CONTACT WITH HOT MOLTEN FUEL. Randles, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 21 Oct 1970. 42p. Dep. NTIS (U. S. Sales Only). EUR F.Fr. 6.65.

On the basis of a simplified representation of a reactor channel containing a region where hot molten fuel becomes mixed with the coolant, the equations of heat transfer and balance are derived in a form which permits the evaluation of the pressure and vapor mass generated by the boiling of the coolant. These equations are then coupled, via the pressure and vapor mass, to the equation of motion describing the ejection of the unboiled coolant from the channel. A simple numerical method of solving the complete set of equations jointly is proposed and has been embodied in a new computer programme TOMOF (thermohydrodynamics of a mixture of two fluids). This programme has been tested with a wide range of data and has proved that the chosen numerical method is effective. In particular, in order to provide a preliminary idea of the results to be expected, the TOMOF programme has been applied to the proposed Ispra UO_2/Na direct contact rig. The results show that the pressure pulses generated by the boiling and ejection process are strongly dependent on the mean size of the dispersed UO_2 globules and on the total mass of Na which interacts thermally with these globules. This is true also for the speed and time of ejection of the unboiled coolant, though here there is less dependence on the mass of interacting Na. Methods of comparing these theoretical results with the coming experimental data are proposed (with a view to checking the theory) and a simple correlation between the peak pressure and pressure pulse half-width is predicted. (auth)

23310 (EURFNR-884) IN AND OUT OF PILE EXPERIMENTS RELATED TO THE SAFETY OF FAST REACTOR FUEL PINS. van der Linde, A.; Kwast, H. (Reactor Centrum Nederland, Petten). Dec 1970. 53p. (RCN-133). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

The R.C.N. work related to safety aspects of fast reactor fuel pins is comprised of fuel pin performance tests, clad failure experiments, and fuel pin loss of cooling experiments. The clad failure experiments are performed on fuel pins, irradiated at relatively severe operating conditions, and on cladding tube sections pressurized out of pile up to failure. After a description of possible mechanisms and consequences of a fuel pin failure, the fuel pin and cladding test equipment and the intended

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experiments on the above mentioned subjects are described. Some preliminary results of completed introductory experiments are presented. (auth)

23311 (JAERI–1201) FAST TRANSIENT ANALYSIS FOR LIGHT WATER POWER REACTOR BY EUREKA, COUPLED NUCLEAR THERMAL-HYDRODYNAMIC KINETIC CODE. Ishikawa, Michio; Kuge, Yasushi; Kambayashi, Yuichiro; Takeuchi, Eiji; Ohnishi, Nobuaki; Hatta, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Dec 1970. 53p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Significant reactivity feedback effect by moderator heating at fast power excursion in light water power reactor has been demonstrated in the SPERT-III · E-core experiments, recently performed. The moderator feedback reactivity has been believed too small to control fast power excursion because of heat transfer time delay from fuel to coolant, and it is concluded in the SPERT report that prompt moderator heating by neutron slowing down should cause the dominant moderator reactivity feedback at power burst time. A code EUREKA-multi-region, nuclear, thermal hydrodynamic, kinetics code, was used to examine this moderator temperature feedback effect through reevaluation of SPERT-III · E-core transient test. EUREKA which includes the prompt moderator heating effect showed excellent analysis results. Moderator temperature feedback effect is therefore proven to be an important reactivity feedback effect at fast power excursion in light water reactor. Consistence between the SPERT experiment and the EUREKA analysis are demonstrated. Currently used adiabatic kinetics calculation results are compared with EUREKA results for reevaluation of adiabatic kinetic model and for examination of moderator temperature feedback behavior. The moderator feedback behaviors with wide parametric calculations, for such as, coolant temperatures, initial power levels, coolant velocities, temperature coefficients, flux distributions in core, and reactor period are discussed. The reevaluation of reactivity accident for current designed BWR reactor is presented. 7 references. (auth)

23312 (ORNL-TM–3145) THERMAL RADIATION TRANSFER OF AFTERHEAT IN MSBR HEAT EXCHANGERS. Tallackson, J. R. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 108p. Dep. NTIS.

A fraction, estimated to be 40%, of the heat-producing noble-metal fission products — Nb, Mo, Tc, Ru, Re, and Te — is expected to deposit on the metal surfaces within the primary fuel-salt loop in a molten-salt reactor. Virtually all of this 40% will be in the heat exchangers. The normal means of afterheat removal is to continue to circulate the primary and secondary salts. The worst abnormal situation arises if the heat exchangers are quickly drained of both primary and secondary salts in circumstances such that all afterheat removal from the heat exchangers is, of necessity, by radiative heat transfer. Whereas such an event will rarely, if ever, take place, the primary system must accommodate the consequences, principally high temperatures, without compromising containment. Steady-state temperature calculations, based on radiative heat transfer in MSBR primary heat exchangers, are presented. Several sizes with ratings from 94 MW to 563 MW and all with the same general configuration were considered. Radial temperature profiles were computed for afterheat rates corresponding to elapsed times from 100 sec to 11 days after reactor shutdown. The effect of the emissivity of the internal radiating surfaces in the heat exchangers was included. The calculations show that the principal single barrier to heat removal is the intermediate shell surrounding the tube bundle. This shell is located just inside the outer shell and, unfortunately, becomes an effective thermal radiation shield. It is shown that heat exchangers with but one shell instead of two as in the MSBR reference design will achieve significant reductions in peak temperatures, particularly in the larger sizes and at low emissivities. No transient case was computed but the upper limit of the initial transient was estimated; the heat capacity of the exchangers affords a cushion which, with the exception of the 563-MW unit, limits maximum temperatures to numbers that are high but not disastrous. Design changes to increase radiating surface areas and to shorten the radial transfer distance through the tube bundle should render the 563-MW exchanger acceptable. 28 references. (auth)

23313 (ORNL-TM–3263) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR NOVEMBER–DECEMBER 1970. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 123p. Dep. NTIS.

The accomplishments during the months of November and December in the research and development program under way at ORNL as part of the U.S. Atomic Energy Commission's Nuclear Safety Program are summarized. Much of this work is in general support of water-cooled power reactor technology, including LOFT and industry programs, and reflects current safety problems, such as measurements of prompt fuel element failure phenomena and the problems associated with the long-term operation of containment spray systems. Several projects are also conducted in support of the high-temperature gas-cooled reactor (HTGR) and liquid-metal fast breeder reactor (LMFBR) programs. Other major projects are those on primary piping and steel pressure-vessel technology. They also include experimental investigations of the attachment of nozzles to shells and the implementation of joint AEC – PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Seismic considerations of particular significance in nuclear plant design are being evaluated in the seismic program. Several of the above projects are also directly related to another major undertaking; namely, the AEC's standards programs, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. The recent activities of NSIC and the Nuclear Safety journal in behalf of the nuclear community are also discussed. Of particular interest in both of these activities is the recent emphasis on environmental effects. (auth)

23314 (RT/ING–(70)3) RAPID POWER TRANSIENTS IN A SODIUM COOLED FAST REACTOR. Tavoni, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 16 Feb 1969. 46p. (In Italian). Dep. NTIS (U. S. Sales Only).

With reference to the safety analysis of the PCC fast reactor, some typical power transients due to the insertion of infinite or finite reactivity ramps were considered; the corresponding fuel element conditions were evaluated. The main parameters were related to the inserted reactivity ramp and to time, and were correlated to each other. The insertion of the control rod system with different delay times was considered. (10 references) (auth)

23315 (WAPD-T–2114) SYSTEM THERMODYNAMICS AND EMERGENCY CORE COOLING SYSTEMS. Redfield, J. A.; Murphy, J. H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sep 1970. Contract AT-11-1-GEN-14. 16p. Dep. NTIS.

Data from a simulated loss of coolant accident and FLASH-3 computer program calculations are compared. It is concluded that FLASH-3 can predict the overall trends in reactor and plant variables following a loss of coolant accident and during operation of emergency core cooling systems. (H.D.R.)

23316 (WAPD-T–2284) DECOMPRESSION OF THE LOFT QUARTER SCALE REACTOR VESSEL: ANALYSIS AND TEST. Redfield, J. A.; Murphy, J. H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sep 1969. Contract AT-11-1-GEN-14. 14p. Dep. NTIS.

Data from the LOFT Semiscale Test Program and FLASH-2 computer program calculations are compared. It is concluded that FLASH-2 can predict subcooled decompression transients following loss of coolant accidents in pressurized water reactors. (H.D.R.)

23317 MISSILE PROTECTION IN NUCLEAR POWER STATION. Iinuma, Y.; Inoue, S. (Chubu Electric Power Co. Inc., Nagoya, Japan). Genshiryoku Kogyo; 16: No. 6, 50-7(Jun 1970). (In Japanese).

When a nuclear power station is built, emphasis in connection with the safety has been mainly on the environmental or social circumstances. However, with the increasing difficulty in acquiring the suitable sites and technological development, there is the tendency recently to protect the power station from the standpoint of engineering; the problem of missile protection is in such a category. This concerns the operation of light-water reactor plants, in particular. On the basis of the data obtained from the safety analysis in nuclear power stations in the United States, the kinds of missiles from both inside and outside the plant are first described, and also considerations concerning the missile protection. Then, design calculations on the missile protection are presented, and finally certain problems concerning the missile protection. (Japan)

23318 SAFETY MEASURES ASSOCIATED WITH THE DEVELOPMENT OF ATOMIC ENERGY. SAFETY IN REACTOR PLANTS. Suguri, Susumu (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 16: No. 4, 113-16(Apr 1970). (In Japanese).

Power producing reactors in operation or under construction are mostly the light-water and the gas types. For the future development, there are an advanced thermal reactor and a fast breeder reactor. For the former, the safety is almost established, even on the too conservative side. For Japan, safety studies for the latter two are important in the early 1970s. The following are described concerning the safety of nuclear reactor

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systems: safety for reactor systems; advance in safety of reactor systems, comparing JPDR and up to No. 3 plant in the Fukushima power station; increase in the reliability of safety instruments, dealing with the relation of failure rates, etc.; safety in the containment vessels, etc.; analysis of loss-of-coolant accidents; analysis of reactivity accidents, describing oversea studies in this connection; and other safety problems, dealing with the cases of an ATR and FBR. (Japan)

23319 DEVELOPMENT OF THE REACTOR PLANT SITES AND THE SAFETY. Uchida, Hideo (Tokyo Univ.). Genshiryoku Kogyo; 16: No. 4, 23-6(Apr 1970). (In Japanese).

Views toward the reactor plant site are becoming more rational and quantitative, because of the advance in nuclear safety and of the necessity for nuclear power generation. The world trends concerning the reactor plant site are reviewed in the following: (1) Safety considerations on the reactor plant site, from the standpoint of possible accidents. Concerning the separation of a reactor plant and the surrounding population, the following two schemes are employed. (a) Possible accidents fairly conservative and the consequences are assumed. And radiation hazards to the population are presumed and analyzed accordingly. (b) The frequency of possible accidents and subsequent hazards are evaluated by the probability technique. Instances of the practice in several countries are described. (2) Safety considerations on the reactor plant site, during normal operation. The problems of multi-plants on a site, population exposure, and warm-water discharge are described. (Japan)

23320 INVESTIGATIONS ON SODIUM BOILING ACCIDENTS IN A LARGE FAST BREEDER REACTOR. I. RADIAL PROPAGATION OF SODIUM BOILING BY THERMAL PROCESS. Nagashima, Kunio; Tezuka, Masaji (Nippon Atomic Industry Group Co., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: 89-94 (Feb 1971).

The radial propagation of sodium boiling by thermal process in a 1,500 MW(e) FBR is analyzed with the BOIP-T code. Since the model used embodies some uncertainty, several modes of molten fuel behavior are considered. The time required for boiling to propagate from one channel to its neighbor is calculated. Even on the most conservative basis, the boiling propagation requires at least 10 sec, which indicates that the radial propagation of sodium boiling could be prevented by a suitable core protection system. (auth)

23321 SAFETY MEASURES FOR NUCLEAR POWER STATIONS WITH REGARD TO PROTECTION OF WATER, SOIL, AND AIR. Mueller, A. (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Bundesgesundheitsblatt; 13: No. 3, 25-30((1970). (In German).

From the point of view of reactor operators it is outlined how the environmental radiation exposure can be reduced. Emphasis is laid more upon the control of normal operation than upon the control of disturbances or large accidents. Already during the design people try to recognize possible disturbances by failure analyses and to take the necessary safety measures. All plant components with high quality requirements are subject to periodical in-service inspections. Safety measures in the FRG are presented for BWR's and PWR's. (INIS)

Power Conversion Systems

23322 (DUN-6216(Rev.1)) POWER: POWER SYSTEM TRANSIENT STABILITY ANALYSIS PROGRAM. Gross, P. D.; Thorson, W. R. (Douglas United Nuclear, Inc., Richland, Wash.). 23 Feb 1971. Contract AT(45-1)-1857. 62p. Dep. NTIS.

POWER is a FORTRAN V computer program for the UNIVAC 1108 to perform power system transient simulations during and immediately after a disturbance. It was written as a general purpose program which could be used to simulate virtually any power system on any computer having a FORTRAN IV compiler and sufficient memory (about 50K words). Subroutine READ reads the input data cards and stores the information in appropriate arrays. It also does some checking of indices to be sure the data is correctly inputted. Subroutine LFLOW then performs a load flow calculation using the Gauss–Seidel iterative method. After the load flow calculation is completed, additional data for the transient calculations are read in by subroutine READ and subroutine TRANS performs the transient calculations. The program includes the option of providing as input actual voltages and phase angles for the faulted bus as a function of time rather than assuming them to be zero for the fault duration. Furthermore, the program performs transient calculations for not only synchronous but also induction machines. (auth)

23323 (TID-25669) LMFBR STEAM GENERATOR DESIGN AND DEVELOPMENT. Sturiale, L. A. (Westinghouse Electric Corp., Tampa, Fla.). Feb 1971. Contract AT(30-1)-4210. 41p. Dep. NTIS.

The "J" modular steam generator was selected by Westinghouse for development as the reference concept for a 1000 MW(e) LMFBR plant. The steam generator is a shell and tube type heat exchanger using sodium as the heat source to preheat, evaporate, and superheat feedwater in a once-through mode of operation. The basic unit of the steam generator is the removable tube module bent into a "J" configuration with large radius bends. The concept design features are described and supporting research and development activities are discussed. (H.D.R.)

23324 PROBLEMS IN STEAM GENERATORS FOR Na-COOLED FAST BREEDER REACTORS. Nakagawa, Hiroshi; Omori, Yasutami (Tokyo Electric Power Co. Inc.). Nippon Kikai Gakkaishi; 73: 561-9(Apr 1970). (In Japanese).

A steam generator for a Na-cooled fast breeder reactor is installed in the secondary coolant circuit; it is essentially a heat exchanger from sodium to water. Difficulties here concern the highly-corrosive nature of Na coolant, and the violent reaction between sodium and water (leading to a rupture of the tubes from a leakage hole). The following are described: function and features of the steam generator; history of the utilization of steam generators, including SIR, subsequent land-based reactors, EBR series, SRE, Enrico-Fermi, Dounreay and BR-5; steam generators being developed; and problems in the development of steam generators, dealing with design and structural materials. (Japan)

23325 A PROCESS AND APPARATUS FOR PRODUCING ENERGY, USING THERMODYNAMIC CYCLES WITH GASES CONDENSIBLE AT AMBIENT TEMPERATURE. (to Commissariat a l'Energie Atomique). British Patent 1,222,712. 17 Feb 1971. Priority date 20 Apr 1967, France.

REACTORS, GAS-COOLED—power cycles for direct-cycle
REACTORS, POWER—power cycles for gas-cooled, development of (D.C.C.)

23326 AI-TYPE STEAM GENERATOR FOR A PROTOTYPE SODIUM-COOLED FAST BREEDER REACTOR. Hayashi, Shigeru; Yorihisa, Katsuaki (Kawasaki Heavy Industries, Ltd., Japan). FAPIG (Tokyo); No. 55, 158-64(Dec 1969). (In Japanese).

A module-type steam generator for the prototype sodium-cooled fast breeder reactor has been designed. A steam generator was also designed for a 50 MW Na loop, to develop steam generators for the prototype reactor. Differing from the conventional steam generators, there are many problems such as the Na-water reaction at the time of a heat-transfer tube rupture, and a severe, thermal shock at the time of a transient temperature change on the Na side, which have been solved in the design. In the module-type steam generators, there are installed four superheaters, four evaporators and two reheaters per loop. The advantages are then the easy development due to small size, and easy exchange of the respective members. (Japan)

Research and Test Reactors

Refer also to abstracts 20941, 21268, 21304, 23029, 23231, 23232, and 23413.

23327 (BNWL-1350) FFTF SITE SAFETY ANALYSIS: METEOROLOGY AND CLIMATOLOGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. 16p. Dep. NTIS.

23328 (CEA-CONF-1730) REACTOR SHIELDING IN THE COMMISSARIAT A L'ENERGIE ATOMIQUE. Devillers, C.; Lafore, P.; Rastoin, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1970]. 25p. (CONF-701208-1). Dep. NTIS (U. S. Sales Only).

From Joint ENEA/IAEA Meeting on the Physics Problems of Reactor Shielding; Paris, France (8 Dec 1970).

Semi empirical calculations on reactor protection were abandoned and the Monte Carlo method used instead. The method of discrete ordinates and the Monte Carlo method are described. Examples using the calculations are given: calculation of the neutron flux in the thermal column of the Harmonie Source Reactor, three dimensional Monte Carlo calculations on the neutron current in the vicinity of the heat exchangers of Phenix and calculations of the neutron flux in the iron column of the Harmonie Source Reactor. The problem of evaluating cross sections is analyzed. The nuclear codes used are enumerated. 34 references. (France)

23329 (CEA-R-3501(2)) RAPSODIE FIRST CORE FABRICATION. Masselot, Yves; Bataller, Simone; Ganivet, Michel; Guillet, Henri; Robillard, Andre; Stosskopf, Francois (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jun 1970. 77p. (In French). (EUR-3862(2)). Dep. NTIS (U. S. Sales Only).

A description is given of the processes, results, and particular technical problems related to the manufacture of the first neutron pile core of the fast reactor RAPSODIE. A critical study was made of the results obtained on the pellets, pins, and sub-assemblies in relation to their specifications. The advantage of the linear mass concept as a quality test for a given manufacturing process is shown. The performances obtained during the first two production runs are examined. (auth) (France)

23330 (CONF-700816-(Vol.2), pp 653-67). DEVELOPMENT OF A CONTINUOUS SAMPLER-MONITOR FOR THE LOFT CONTAINMENT ATMOSPHERE. Schindler, R. E.; Hammer, R. R.; Black, D. E.; Lakey, L. T. (Idaho Nuclear Corp., Idaho Falls).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

A Continuous Sampler-Monitor (CSM) has been developed for the LOFT Integral Test Program. During the LOFT, the CSM will remotely sample and determine the airborne noble gas, total iodine, and organic iodide concentrations and will monitor changes in total activity in the LOFT containment atmosphere. In the current CSM, a 2 liter/min. stream of the atmosphere is continuously drawn into a scrubber where the elemental iodine and most of the particulate fission products are washed into a stream of basic-thiosulfate scrubbing solution; the noble gases, organic iodides, and hypoiodous acid remain in the gas stream. The scrubbed gas stream and the scrubbing solution flow in a common line to a sampling station located outside the containment building where they are separated. The gross activity levels of the separated streams are monitored, and samples of each stream are analyzed to determine the concentrations of individual nuclides in the containment atmosphere. In tests conducted with low concentrations of iodine or xenon in an 86-ft^3 vessel under simulated Loss-of-Coolant Accident atmospheric conditions, the CSM performed satisfactorily. Xenon values from the CSM were representative within 4% of xenon concentrations in the containment atmosphere. The CSM total iodine values were accurate to at least 50%, and the CSM organic iodide values to within 30% when corrected for the methyl iodide absorbed in the scrubbing solution. The gross activity monitors provided reasonable gross activity records. 7 references. (auth)

23331 (CONF-700816-(Vol.2), pp 668-82) APPLICATION OF THE CONTINUOUS SAMPLER MONITOR (CSM) AS A HAZARD EVALUATION INSTRUMENT. Schultz, R. J. (Idaho Nuclear Corp., Idaho Falls).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

The practical applications of the Continuous Sampler Monitor (CSM) in the LOFT Integral Test Program and the possible use of the CSM in the nuclear power industry are discussed. The unique features that the CSM provides for gathering information concerning the conditions and radioactivity levels in the containment atmosphere following a loss-of-coolant accident (LOCA) are described. These unique features are: whole air sample remotely taken from the containment vessel atmosphere, real time activity profile of airborne fission products, and rapid measurements of activities to below 0.05 $\mu Ci/ft^3$ of containment atmosphere. These features make the CSM valuable as a conventional instrument for monitoring nuclear power plant containment atmosphere. During normal plant operations the CSM can be operated without scrubbing solution as a constant air monitor with remote sampling capabilities. In the event of a massive spillage involving radioactive material, loss-of-coolant accident, or any event leading to the release of fission products to the containment atmosphere, the scrubber system can be activated and the sampler used for hazard evaluation. The hardware to be used in LOFT and the adaptations that will render the instrument usable for industry are also described. The data obtained from the CSM's during the LOFT tests are to be used both for analytical model evaluation and hazards evaluation. The specific functions of the LOFT CSM's are: to continuously monitor the activity present in the containment vessel atmosphere for operational control, and to provide samples of the containment vessel atmosphere as a function of time for detailed analysis of radionuclide behavior. (auth)

23332 (DOCKET-50231-73) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Variance from Performance Specifications in the Safety Analysis Report. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 17 Mar 1971. 14p. Dep. NTIS.

Possible deformation of bolts which attach the outer head to the reactor vessel flange is analyzed. The deformation may have occurred during heating and cooling of the reactor cooling system. Bolt strain is calculated. Corrective actions are described. (D.C.C.)

23333 (EURFNR-800) MEASUREMENT OF ENERGY AND PLACE DEPENDENCE OF NEUTRON IMPORTANCE FUNCTION IN FAST CRITICAL ZERO-ENERGY FACILITIES. Korthaus, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Translation of report KFK-1141. 131p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Measurements of the energy and spatial dependence of neutron importance in the SNEAK-assemblies 3A-2 and 3B-2 are reported, as well as the determination of the energy spectra and intensities of the neutron sources used for the measurements. The importance measurements are compared with multigroup calculations. The various measuring methods are described in detail. In addition, the mathematical properties of the importance function and some aspects of its numerical calculation are discussed. 62 references. (auth)

23334 (EURFNR-874) COMMENTS ON THE CALCULATION OF REACTION RATE TRAVERSES. Kiefhaber, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Nov 1970. 35p. (KFK-1314). Dep. NTIS (U. S. Sales Only).

Work performed under United States-Euratom Fast Reactor Exchange Program.

The influence of calculational methods and some changes in the nuclear data on the calculated reaction rate traverses is analyzed. As an example the traverses for ^{235}U fission and ^{238}U capture and fission in the assembly SNEAK 3A2 are studied. Besides some sensitivity studies the adequacy of the use of a global buckling for the separated direction in one-dimensional calculations is checked by two-dimensional calculations. The influence of reflecting zones outside the blanket has been determined. The effects of applying heterogeneity-corrected group constants, the REMO-correction, two different types of transport cross sections and two different forms for the energy dependence of the fission spectrum are studied. No major deficiency in the generally used calculational methods has been found so that the existing discrepancies between theory and experiment must be caused either by errors in the measurements or more probably by deficiencies in the nuclear data. 10 references. (auth)

23335 (GEAP-10010-26) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Twenty-Sixth Quarterly Report, August-October 1970. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Nov 1970. Contract AT(04-3)-540. 102p. Dep. NTIS.

REACTOR FUEL ELEMENTS—fabrication of plutonium oxide (PuO_2)-uranium oxide (UO_2) rod type
—design parameters of plutonium oxide (PuO_2)-uranium oxide (UO_2)
SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR—fuel elements for, fabrication and design parameters of plutonium oxide (PuO_2)-uranium oxide (UO_2)
—startup testing of plutonium oxide (PuO_2)-uranium oxide (UO_2) fueled, (E/T)
—physics measurements for plutonium oxide (PuO_2)-uranium oxide (UO_2) fueled, (E/T)
—maintenance during August to October 1970
—operations during August to October 1970 (D.C.C.)

23336 (JPRS-52290, pp 46-65) STUDY OF THE POWER AND THERMAL EFFECTS OF THE BR-5 REACTOR. Aristarkhov, N. I.; Efimov, I. A.; (and others). Translated from Studies in Physics and Power Engineering.

The relationship between the power of a reactor and the reactivity (position of the control rods) was studied in several modes (power level 5.0-0.25 MW, coolant flow rate 240-10 m^3/hr). The measurements were performed using the standard automatic control system. The first method consisted of studying the displacement of control rods with a single, sudden change in power (amplitude of jump 10%). Comparison of curves produced at various power levels allows the power and thermal components of the change in reactivity to be determined. In the second method a pseudo-random binary signal was applied to the reactor power controller. The reactor changed its power output

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by ±1% from the fixed mean power level upon receipt of the signal. The mutual correlation between the perturbation and the position of the control rod was calculated. The calculations performed allow the individual components of the temperature effects of reactivity to be estimated on the basis of experimental data. (auth)

23337 (JPRS-52290, pp 84-102) STUDY OF THE EFFICIENCY OF VARIOUS MATERIALS IN THE BFS-16 FAST REACTOR. Gorbatov, N. E.; Mamontov, V. F.; (and others). Translated from Studies in Physics and Power Engineering.

The results of experimental studies of perturbations resulting from various materials in the BFS-16 fast reactor are presented. A comparison of calculated and experimental quantities was performed. The calculations considered the effects of resonant self-screening of the specimen and perturbation of the neutron field by the specimen. Methodology and results are presented from a calculation of the influence of scattering of the specimen on unblocking of resonant cross sections of the surrounding medium. (auth)

23338 (JPRS-52290, pp 103-8) INTEGRAL METHOD OF EXPERIMENTAL DETERMINATION OF ν_{eff} IN REACTORS WITH A HARD NEUTRON SPECTRUM. Mogil'ner, A. I. Translated from Studies in Physics and Power Engineering.

An experimental method for measuring ν_{eff} in zero power reactors with an effective neutron spectrum of over 1 keV is described. The measurement is based on the use of the method of statistical weights. (H.D.R.)

23339 (JPRS-52290, pp 125-41) CHANGE IN REACTIVITY OF THE BR-5 REACTOR. Efimov, I. A.; Inyutin, E. I.; (and others). Translated from Studies in Physics and Power Engineering.

The results of processing of experimental data on the change in reactivity of the BR-5 reactor during one recent interval of continuous operation at nominal power are presented. The mean rate of decrease in reactivity, averaged over its diurnal fluctuations, was calculated. Daily fluctuations in reactivity were noted, resulting from the difference between day and night temperatures. A difference was noted between the effective shield temperature and the temperature recorded in the nonmoving portion of the shield. Results are presented from calculation of the rate of decrease of reactivity as a result of the change in isotope composition of the core and fuel swelling. The difference between the calculated and experimental values of rate of change of reactivity of the BR-5 reactor may result from calculation inaccuracy, inaccuracy in the dependence of the fuel swelling on burnup, and from unconsidered effects (for example, changes in the effectiveness of the control system). (auth)

23340 (N-70-41902) PRECRITICAL ANALYSIS OF A POWER-TAILORED FAST-SPECTRUM MOLYBDENUM REFLECTED CRITICAL ASSEMBLY. Mayo, Wendell (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sep 1970. 16p. (NASA-TM-X-52895). NTIS.

A series of critical experiments to estimate the fuel loading requirements for a power-tailored fast-spectrum reactor is discussed. The materials used are ^{7}Li, N_2, ^{235}U, ^{238}U, and the refractory metals Mo, Hf, Ta, and W. The conceptual reactor, the critical machine, the fuel element design, neutronic calculation procedures, and results of precritical calculations are illustrated. Power distribution calculations are also presented for the proposed fuel loading schedule. (STAR)

23341 (N-71-10271) NEUTRON FLUX MEASUREMENTS IN A THREE-CAPSULE D_2O TANK IN THE NASA PLUM BROOK MOCKUP REACTOR. Gumto, Klaus H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct 1970. 26p. (NASA-TM-X-52910). NTIS.

Previous experiments with a capsule surrounded by D_2O instead of H_2O showed that the thermal neutron flux increased ten times in the regions of the HT-2 test hole away from the core. Experiments with a D_2O tank containing three identical capsules were conducted. Compared to a single capsule in H_2O, the sum of the flux in all three capsules was three times higher, the flux in the capsule nearest the core was two times as high, and the flux in each of the other two capsules was one half as high. Gamma heating was also measured. (auth) (STAR)

23342 (ORNL-4635) FINAL REPORT ON THE FIRST FUEL ROD FAILURE TRANSIENT TEST OF A ZIRCALOY-CLAD FUEL ROD CLUSTER IN TREAT. Lorenz, R. A.; Hobson, D. O.; Parker, G. W. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 83p. Dep. NTIS.

The first fuel rod failure experiment in Transient Reactor Test Facility (TREAT) was performed with a seven-rod bundle of 27 in. long Zircaloy-clad UO_2 fuel rods in flowing steam atmosphere. A water reactor loss-of-coolant accident was simulated by operating TREAT reactor at constant power for 20 sec so that fission heat in the UO_2 pellets caused the Zircaloy cladding temperature to rise 72°F/sec to a maximum of approximately 1800°F. The fuel rods were initially pressurized with helium between 115 and 215 psia (77°F) to simulate accumulated fission gas. The Zircaloy cladding swelled and ruptured resulting in 48% blockage of the bundle coolant channel area at the location of maximum swelling. The average rod maximum circumferential swelling was 36%. Calculations related the hoop stress and ultimate strength at the onset of rapid expansion. The ideal gas law was used to calculate the rate of cladding expansion from measured rod temperature and internal pressure. Metallographic examination revealed ductile ruptures and significant oxygen pickup. Zirconium-steam reaction was 0.2%. The center rod was preirradiated to 650 Mwd/MT in the Materials Testing Reactor (MTR) to build up an inventory of fission products and to determine irradiation effects on fuel rod failure characteristics. No irradiation effect was seen from this low-level irradiation on the swelling and rupture characteristics. A form of fuel rod failure propagation apparently occurred when chips of fragmented UO_2 from the rupture hole in the center irradiated rod contacted one of the outer rods resulting in stress concentrations and rupture of the outer rod at the point of contact. The release of gaseous fission products ^{133}Xe and ^{85}Kr from the irradiated center rod was in the 0.1% to 0.2% range. The release of volatile fission products ^{131}I and ^{137}Cs was similar indicating negligible retention on the inner Zircaloy cladding surfaces. Approximately 6.7% of the ^{131}I released from the center rod was in a chemically unreactive form. 21 references. (auth)

23343 (ORNL-TM-3339) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, OCTOBER-DECEMBER 1970. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). 9 Mar 1971. 26p. Dep. NTIS.

Control-plate-bearing problems recurred and reduced the reactor operating time to 83.1% which resulted in an operating time for calendar 1970 of 88%. Two of the redesigned control-plate bearings which were expected to last for more than 15 fuel cycles actually broke during their fifth cycle of operation. Debris from the broken bearings caused additional rod-drive problems during precritical control-plate tests. Installation of a set of reworked control plates resulted in the incomplete insertion of a safety plate during a reactor scram. The primary water leak at the HB-1 Marman flange increased to 1.5 gpm but has seemed to stabilize at that point. (auth)

23344 (UJV-2375.RPA.) A STUDY OF THE CONTROL SYSTEM OF A MATERIALS TESTING REACTOR. Kovanic, P.; Rygl, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [nd]. 33p. (In Czech). NTIS (U. S. Sales Only).

Three conception variants were worked out for the control system of a materials testing reactor, based on the utilization of movable detectors. The first variant uses an analog-type technique for the treatment of impulses from neutron detectors, the second uses a set of three special-purpose digital computers, and the third employs three independent minicomputers of a universal type. Owing to the use of movable neutron detectors, all three versions meet the actual requirements for system reliability and reactor safety. The second variant performs better than the first in ensuring reactor start-up and operation at a very low power level. However, both variants require that the system be in addition equipped with rather extensive apparatus for the control of vital parameters of experimental installations operated simultaneously with the reactor. The third variant represents a compromise between reactor reliability and safety, ensuring continuous checking of both the reactor control system and the vital parts of the control system of the experimental installation. (auth) (INIS)

23345 (UJV-2387.RF.) EFFECT OF A CONIC REFLECTOR AND SURFACED FUEL ELEMENTS ON THE CRITICAL HEIGHT IN THE TR-O REACTOR. Turzik, Z. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [nd]. 13p. (In Czech). NTIS (U. S. Sales Only).

For experimental heavy-water reactor TR-O with a conic vessel bottom, a set of equations was derived which can be used to determine the effect of water in the bottom cone, constituting an additional reflector, on the value of the reactor critical height. A graded set of concentric cylinders is substituted for the conic bottom, thus making it possible to apply the method in principle to any bottom shape. Further, the effect of surfaced fuel elements on the critical D_2O level is calculated. This situation is a consequence of reactor control by adjustment of the moderator level. The computations were performed by a GIER computer, and the most important results are presented in graphic form. (auth)

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23346 (UJV-2388.A.) MEASURING DEVICE FOR DETERMINATION OF OUTPUT ACCURACY AND STABILITY OF THE MODERATOR LEVEL DETECTOR AT THE TR-O REACTOR. Stulik, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 13p. (In Czech). NTIS (U. S. Sales Only).

A detailed description is given of the measuring device, its performance, and individual circuits. A method of performance check-up is described, used to test the input element of the D_2O-level detector, and thus to assess the overall accuracy and stability. Block diagrams of the whole apparatus and of some of the circuits are shown along with wiring diagrams of the circuits. (INIS)

23347 (UJV-2408. RF.) USE OF MULTIGROUP DIFFUSION CONSTANTS FOR A PHYSICS CALCULATION OF THE ZRR EXPERIMENTAL FAST REACTOR. Tinka, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 16p. (In Slovak). NTIS (U. S. Sales Only).

A series of check calculations in the multigroup one-dimensional approximation was performed to determine the effect of some factors on the fundamental characteristics of a reactor. The results of a physics calculation for the ZRR experimental fast reactor were employed. The effect of the resonance self-shielding coefficient and the method for reducing the number of groups are analyzed, and the six-group microconstants used in the calculations are given. (INIS)

23348 (UJV-2419.R,F.) FISSION HEAT EVOLUTION AND THE RELATIVE NUMBER OF REACTIONS IN THE ZRR REACTOR. Tinka, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 7p. (In Slovak). NTIS (U. S. Sales Only).

To supplement the fundamental core characteristics of the ZRR experimental fast reactor, a program called INQUANT was set up for the GIER computer. Computations were performed for the variant with graphite reflector and withdrawn control elements and, eventually, an inserted central compensation rod. The results are presented in tables and graphs. (INIS)

23349 PULSED REACTOR EXPERIMENT AND ANALYSIS FOR REACTIVITY ACCIDENT EVALUATION. **Imai, Munemaro (Hitachi Ltd., Tokyo); Kato, Hidemasa; Tagami, Takashi; Yamada, Shuji; Nishikawa, Motoyuki. Hitachi Hyoron; 52: 355-60(Apr 1970). (In Japanese).**

Using the improved swimming pool type research reactor, the pulsed experiment was performed. This research object was as follows: (1) Comparing the actual core dynamic characteristics (reactivity coefficients, etc.) with theoretically computed values. (2) Confirming the self-control effect by analysing the feed back reactivity. (3) Checking the effect and reliability of automatic stopping instruments (from scram signal issuing to control rod insertion). (4) Improvement and reliability check of computer code (REACT-R II) for analysing the characteristics accompanying the reactivity accident. (5) Establishing the detecting method of neutron flux, temperature, pressure, etc., accompanying with the abrupt transient. The experiments were performed by pulsed operation changing the input pulsed reactivity. Above the input pulsed reactivity of 1.0% $\Delta k/k$, the peak output was fully due to Doppler effect. The theoretically computed value was very exact. This shows that the Doppler effect was properly introduced. Furthermore, the detecting techniques were also developed. The scram system reliability was also confirmed by 400 times operations. (Japan)

23350 DESIGN AND CONSTRUCTION OF THE FUEL FOR THE DCA. **Nishikawa, Kazuyuki; Tsuchiya, Takao (Furukawa Electric Co. Ltd., Tokyo). FAPIG (Tokyo); No. 56, 241-4(Mar 1970). (In Japanese).**

The fuel was designed and constructed, from material preparation to fabrication and assembly, by Furukawa Electric Co., for the DCA (heavy-water, experimental, critical facility). The fuel assembly consists of 28 fuel rods and pressure tube; each fuel rod is made up of UO_2 pellets, other structural components being of an aluminum alloy. The total amount designed and produced is the equivalent of 71 operating fuel clusters and 30 experimental fuel clusters; the enrichment used was 1.2%, 1.5%, and natural. The works performed included UO_2 powder, pellets, fuel rods, pressure tube, fuel assembly, and inspection. The design, the specifications, and the actual works carried out on the DCA fuel are described. (Japan)

23351 FIELD CONSTRUCTION-ASSEMBLY WORKS FOR THE DCA. **Isozaki, Osamu (Fuji Electric Engineering Co. Ltd., Kawasaki, Japan). FAPIG (Tokyo); No. 56, 265-7(Mar 1970). (In Japanese).**

The D_2O-moderated critical assembly (DCA) went critical successfully on December 28, 1969. Field construction-assembly works by the Fuji Group, contributing to this success on schedule, are described. Due to unexpected contingencies, new technology, etc., works by the Group were occasionally delayed. Such difficulties, however, were largely overcome by the "part" procedure program. The descriptions are in the following: adoption of the part procedure program; coordination among the Group and other firms; problems in the construction-assembly schedule, including the core tank, pumps, etc.; washing, drying, and helium leak-test; D_2O injection; and over-all functional inspection, and approach to criticality. (Japan)

23352 TEST ON THE WELDING REPAIR-WORK OF JRR-2. GAS-TIGHT WELDING AT THE INNER CIRCUMFERENCE OF THE SUPPORT RING FOR A HEAVY-WATER TANK. **Keikinzoku Yosetsu; No. 91, 311-24(Jul 1970). (In Japanese).**

A leak had occurred at the inner circumference of the support ring for the D_2O tank of JRR-2 (CP-5 type reactor), which was temporarily repaired. For the future permanent repair of the leak, tests have been made to know the practical procedure and working conditions. The positions of welding are the inner circumference of the ring joining the flange of the D_2O tank, the part of boral-curtain housing and drain holes through the flange. The welding was mostly all-automatic MIG welding, using an aluminum seal ring; for the two other positions, it was semi-automatic MIG welding. From the tests, both preliminary and with the mockup, the procedure was established to ensure the future permanent repair-work. The work under intense radiation is a significant problem encountered. (Japan)

23353 REACTIVITY CONTROLLING EQUIPMENT. **Yoshida, Noriaki (Fuji Electric Co. Ltd., Tokyo); Ueyama, Norihiko. FAPIG (Tokyo); No. 56, 250-4(Mar 1970). (In Japanese).**

The control system of the D_2O Critical Assembly consists of control rods which change reactivity gradually and safety rods which stop reaction instantly. The safety rods are normally driven by an electric motor through a reduction gear, and hung with electro-magnets. In case of emergency, they drop into the reactor under the influence of gravity by de-energizing the electro-magnets. This rod drive mechanism was tested with simulated safety rods to confirm drop-characteristics, shock, the effect of a dash pot and so on. The safety rods and control rods A are made of cylindrical cadmium tubes coated inside and outside with 52S aluminum. The top and bottom plugs are hermetically welded in order to prevent heavy water infiltration. Being used for the fine change of reactivity, control rods B are made of stainless steel tube containing cadmium pellets. The extension rods of three different length are prepared to elongate the effective stroke of control rods. The container and drive mechanism for neutron source, the automatic measuring equipment for neutron flux distribution and the overflow pipe which protects against the abnormal rise of water level in the core tank are also provided. (Japan)

23354 MEASUREMENT OF CERTAIN CHARACTERISTICS OF NEUTRON FLUXES IN EXPERIMENTAL ARRANGEMENTS OF THE SM-2 REACTOR BY REFERENCE TO GOLD ACTIVATION. **Klinov, A. V.; Kormushkin, Yu. P.; Frunze, V. V.; Tsykanov, V. A.** This paper was summarized in At. Energ. (USSR); 28: 491(Jun 1970) as paper No. 394/5486. (In Russian).

The thermal and superthermal neutron flux densities in experimental arrangements of the SM-2 reactor were measured by a method based on the activation of gold films. The measuring method is briefly described. A correction is introduced for resonance self-screening in the gold activation cross section. It is shown that the flux density of the thermal neutrons in the water space during the operation of the reactor at nominal power is 3.3×10^{15} neutrons/cm^2 · sec. The measuring error is no greater than 7%. (auth)

23355 INVESTIGATION OF TEMPERATURE FIELDS IN FAST REACTOR FUEL ELEMENTS WITH VARIABLE POWER DISTRIBUTION OVER HEIGHT OF CORE. **Dobrovol'skii, V. F.; Zhukov, A. V.; Sviridenko, E. Ya.; Subbotin, V. I.; Ushakov, P. A.** This paper was summarized in At. Energ. (USSR); 28: 490(Jun 1970) as paper No. 391/5348. (In Russian).

The temperature fields of the central, lateral, and angular elements of a model of a BOR reactor fuel assembly with a cosinusoidal power distribution over the height of the model were determined experimentally. Heat flux varying with the length brings about a deformation of the temperature profile in the channel, through the variable amount of heat supplied at each portion of the channel. This results in changes in the numerical values of the heat-transfer coefficients along the channel, as compared to the q = const. condition. A decline in heat-transfer coefficients in the top of the BOR reactor core as a result of variable power distribution constitutes no hazard to the performance of the fuel

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elements, since the numerical values of the wall-liquid temperature heads are very small when sodium coolant is employed. Maximum nonuniformities in the temperature of the BOR reactor fuel elements can be estimated from the heat flux averaged over core height, on the basis of experimental data obtained with q = const. (auth)

23356 INTERMEDIATE-NEUTRON SPECTRA IN THE EXPERIMENTAL CHANNELS OF A WATER-COOLED, WATER-MODERATED REACTOR. Starodubtsev, S. V.; Vainshtein, G. M.; Stryapunin, V. B. This paper was summarized in At. Energ. (USSR); 26: 449(May 1969) as paper No. 291/4919. (In Russian).

The intermediate-neutron spectra in the vertical and horizontal channels of the VVR-S reactor were measured with resonance detectors. A reference superthermal neutron spectrum, the well-known spectrum $\varphi(E) \sim 1/E$, in a graphite prism $1000 \times 1000 \times 1000$ mm^3 in size, was used for comparison (in the vertical channel of the thermal column). A selection of resonance detectors permitting measurement of neutron spectra in the 1 to 10,000 eV neutron energy range was used. The samples were chosen rather thin to avoid interference with the spectrum. Subtraction of the 1/v contribution and resonance blocking were used to measure the epithermal neutron spectrum in the vertical experimental channel. Only the 1/v subtraction was used in the horizontal channel and the thermal column. The standard spectrum in the graphite prism coincided with the calculated $\varphi(E) \sim 1/E$, while the measured intermediate-neutron spectra in the horizontal and vertical channels deviated somewhat from the 1/E law, because these measurements were made in regions of nonuniform neutron accumulation. The error in the measurements was 20%. (auth)

23357 QA FOR NUCLEAR FUEL. Powers, H. G.; Polentz, L. M. Power Eng.; 75: No. 2, 46-9(Feb 1971).

The quality assurance program for the Fast Test Reactor fuel pins is described. (H.D.R.)

23358 QUANTITATIVE DETERMINATION OF ^{54}Mn IN THE COOLANT FLUID OF VVR-S REACTOR. Ionescu, G.; Ionescu, E.; Alexan, Z. (Inst. of Nuclear Physics, Bucharest). Stud. Cercet. Fiz.; 22: 935-42(1970). (In Rumanian).

The quantitative determination of ^{54}Mn in the coolant fluid circuit of the VVR-S Reactor has been established. For this polarographical and radiometrical methods have been used. ^{54}Mn in the coolant water of the primary circuit has been very difficult to determine by polarographic methods due to too small quantities. The quantitative results on ^{54}Mn determination were obtained by the radiometric method, using gamma-scintillation spectrometry. The principle of the method consists in carrying out radiometric measurements by use of standard samples of well known activities. The results obtained with standard samples were then compared with those obtained with water samples, using the facilities of gamma-spectrometry. 11 references. (auth)

23359 MEASUREMENT OF ANISOTROPIC DIFFUSION COEFFICIENTS IN H_2O-Al SLAB. Kaneko, Yoshihiko; Akino, Fujiyoshi; Kurokawa, Ryosuke; Kitadate, Kenji (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: 70-9(Feb 1971).

Diffusion coefficients were measured for an H_2O-Al slab lattice (H_2O 8 mm, Al 8 mm) in parallel ($D_{||}$) and perpendicular ($D_\perp$) directions, applying the pulsed neutron technique. The measured results were compared with those of theoretical calculations based on the collision probability method, taking into account anisotropic scattering, and assuming a source neutron distribution of Maxwellian configuration. Fairly good agreement between theory and experiment was obtained for $D_\perp$ but a considerable discrepancy, of the order of 19%, resulted for $D_{||}$. The relation between measured and theoretical quantities in a heterogeneous system are also discussed. 11 references. (auth)

23360 RADIATION CHANNEL OF THE IRT REACTOR OF TOMSK POLYTECHNICAL INSTITUTE. Sakharov, E. S.; Chuchalin, I. P.; Skorikov, A. G.; Akimova, R. I.; Karnaukhov, V. V. At. Energ. (USSR); 29: 43-5(Jul 1970). (In Russian).

The design and operating characteristics of the improved γ irradiation facility for the Tomsk pool-type reactor are described. In the facility, the γ source material to be activated is transported by pneumatic rabbit tube between the activation position in the reactor reflector and a moveable hollow cylinder (γ irradiator) outside the pool. The distance between the reactor core and the activation position can be varied, and the γ intensity of the source is increased by arranging the material in layers. Data are presented on the effects of source activation distances on γ buildup factors and reactor reactivity and on the effects of the distance between the source layers on γ buildup factors. It is concluded that the efficiency of the facility can be increased in the future by increasing the number of source layers and using pure indium as the source. (R.V.J.)

23361 ANALYSIS OF BARE AND REFLECTED METAL CRITICAL ASSEMBLIES USING ENDF/B DATA. Ludewig, Hans (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 44: 18-26(Apr 1971).

An analysis of five metal critical assemblies constructed at the Los Alamos Scientific Laboratory is described. Nuclear data based on ENDF/B Versions 1 and 2 and the DSN method are used in the analysis. Special attention is focused on the variation of α (the ratio of capture-to-fission cross sections) for ^{239}Pu. A study of the sensitivity of k_{eff} to the number of angular quadratures and the scattering model used in the calculation is also investigated. Finally, in addition to determining the reactivity of each core, the spatial variation of a spectral index for two cores is investigated. 19 references. (auth)

Rocket and Space Reactors

Refer also to abstracts 21257 and 23232.

23362 (CONF-700837-1) DESIGN AND DEVELOPMENT OF A FLUIDIC CHAMBER PRESSURE CONTROL SUBSYSTEM FOR THE NERVA ENGINE. Sheridan, E. A.; Carroll, John ((Aerojet Nuclear Systems Co., Sacramento, Calif.). 1970. 6p. AIAA, New York, N. Y. $2.00.

From AIAA guidance, control and flight mechanics conference; Santa Barbara, Calif. (17 Aug 1970).

A design concept for a nuclear-rocket-engine fluidic-chamber pressure-control subsystem is presented together with the development approach used for the major components. Nuclear-rocket engine system performance requirements dictate a different design philosophy than is used in commercial fluidic systems. Static and dynamic fluidic subsystem requirements for the nuclear-rocket engine are examined in terms of performance, calculations, and test data. 3 references. (auth)

23363 (IN-1443) SPHERICAL GAS CORE REACTOR CRITICAL EXPERIMENT. Lofthouse, J. H.; Kunze, J. F. (Idaho Nuclear Corp., Idaho Falls). Feb 1971. Contracts AT(10-1)-1230; C-67747-A. 73p. (NASA-CR-72781). Dep. NTIS.

Criticality experiments using gaseous fuel are reported. The experiments were relatively "clean" and should serve as benchmarks for calculational purposes. The inner spherical gaseous fuel region (127 cm dia) was located in a 183 cm diameter cavity surrounded by 91 cm of commercial grade heavy water. The critical mass was 8.4 kg of uranium in gaseous UF_6 form. The second configuration had hydrogen added between the fuel and the cavity wall. The third added structural material to the cavity wall. The critical mass increased to 12.86 kg and 29.2 kg of uranium, respectively. Four methods of controlling reactivity were examined. Results were favorable, with total control system worths as high as 18 dollars. 17 references. (auth)

23364 (N-70-42181) ULTRASONIC MEASUREMENT OF CORE MATERIAL TEMPERATURE. Final Report. Lynnworth, L. C.; Patch, D. R. (Parametrics, Inc., Waltham, Mass.). Mar 1970. Contract NAS3-10284. 56p. (NASA-CR-72717). NTIS.

Sheaths designed to protect a thin wire ultrasonic thermometer from 5300 R graphite/hydrogen environment expected in nuclear rocket engines were laboratory tested. Eight Ta-sheathed lines were installed in mock fuel elements and cycled in a graphite/helium environment up to 5400 R. The sheaths survived. Attenuation was overcome, permitting signals to be observed clearly, and measured automatically. The measured transit times exhibited drift, which is not yet explained. (auth) (STAR)

23365 (N-70-43127) SYNTHESIS OF CALCULATIONAL METHODS FOR THE DESIGN AND ANALYSIS OF RADIATION SHIELDS FOR NUCLEAR ROCKET SYSTEMS. VOLUME I. RADIATION MEASUREMENTS IN A NUCLEAR ROCKET PROPELLANT TANK MOCKUP USING SIMULATED LIQUID HYDROGEN. Woodsum, H. C.; Rowland, J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). 30 Sep 1968. Contract NAS8-20414. 200p. (NASA-CR-102888(Vol.1); WANL-PR(LL)-22(Vol.1)). NTIS.

The radiation environment was investigated on and in a modified 72-inch diameter Saturn 1-B LOX tank suspended above a nuclear rocket critical assembly. Measurements were performed with the tank filled with two different densities of polyethylene to simulate the neutron and photon transport properties in liquid hydrogen. A critical mockup of a NERVA reactor experiment reactor provided a source of neutron and gamma radiation with the desired spectral characteristics. Two different shield mockups were in-

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terposed between the reactor and the propellant tank. Measurements of neutron fluxes and fast neutron and gamma dose rates were made. Thermal neutron fluxes and neutron spectra on the surface of the tank in a ground test environment were obtained for use in the evaluation of after-shutdown problems associated with activation of the propellant tank structure and radiation analysis methods. Effects of test cell background were determined experimentally. Comparisons of calculated and measured neutron and gamma radiation levels are included. The two-dimensional discrete ordinates transport code, DOT, was employed to generate neutron fluxes throughout the reactor assembly; and the data processing code, NAGS, generated flux source data for use in the point kernel and Monte Carlo analyses. Calculations in the propellant tank were performed utilizing the KAP-V point kernel code and the FASTER Monte Carlo code. (auth) (STAR)

23366 (N-71-10373) ANALYTICAL STUDIES OF IN-REACTOR TESTS OF A NUCLEAR LIGHT BULB UNIT CELL. Latham, Thomas S.; Bauer, Harold E. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1970. Contract SNPC-70. 86p. (NASA-CR-111098; J-910900-6). NTIS.

Analytical studies were conducted to determine the performance and design characteristics of a small model of a nuclear light bulb unit cell suitable for testing in a nuclear reactor. Three nuclear test reactors were considered: Pewee and the nuclear furnace, which are solid-core nuclear rocket fuel element test reactors, and the high flux isotope reactor. Demonstration tests with these thermal neutron flux environments created thermal radiation fluxes corresponding to black-body radiating temperatures of 12,500 to 14,600 R for models having reflecting walls and operating pressures of 500 atm. Preliminary design analyses of the test region pressure vessel, reflective liner, fuel handling system, and instrumentation were performed. Three types of tests of increasing complexity were considered: (1) a demonstration that nuclear fuel can be contained fluid dynamically while fissioning in a gaseous cloud; (2) a demonstration that internally cooled transparent walls are capable of withstanding both the nuclear radiation and thermal environments anticipated for a nuclear light bulb engine; and (3) a demonstration that seeded propellant can be heated to exhaust temperatures in excess of those presently attained in a solid-core nuclear rocket. (auth) (STAR)

23367 (N-71-10379) DEVELOPMENT AND TESTS OF SMALL FUSED-SILICA MODELS OF TRANSPARENT WALLS FOR THE NUCLEAR LIGHT BULB ENGINE. Vogt, Paul G. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1970. Contract SNPC-70. 96p. (NASA-CR-111100; J-910900-3). NTIS.

Fabrication techniques were developed for constructing models using thin-walled fused silica tubing. Model configurations which provide satisfactory vortex flow patterns were derived, and the models were tested in a thermal environment similar to that in the engine. The transparent wall in the engine surrounds the fuel region and separates it from the annular propellant duct. A vortex, driven by a transparent buffer gas, is employed to isolate the fuel from the wall. The wall is internally cooled and has provision for circumferential injection of buffer gas to drive the vortex. Optical transmission characteristics of arrays of coolant tubes were measured, and procedures for predicting heat transfer rates and stresses in the tubes were developed. (auth) (STAR)

23368 (N-71-10404) ANALYTICAL STUDIES OF STARTUP AND DYNAMIC RESPONSE CHARACTERISTICS OF THE NUCLEAR LIGHT BULB ENGINE. Bauer, Harold E.; Rodgers, Richard J.; Latham, Thomas S. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1970. Contract SNPC-70. 121p. (NASA-CR-111097; J-910900-5). NTIS.

Analytical studies were conducted to evaluate systems for control of the reference nuclear light bulb engine during start-up and at nominal full-power operating conditions. Analytical models of the control systems were incorporated in the digital computer simulation program developed previously to determine operating conditions of the reference engine during start-up and the transient response of the engine to various perturbations at the nominal full-power operating level. Additional analyses were conducted to determine the effects of off-design flow fluctuations and fabrication tolerances on the operating conditions of the reference engine, to compare critical mass calculations with results of experiments on a seven-module cavity reactor to determine the design parameters such as radiator materials and operating temperatures and pressures for a space radiator to reject a portion of the moderator heat load, and to investigate the design characteristics and performance of an alternate nuclear light bulb engine configuration employing unit cells of smaller diameter than those envisioned for the reference engine. (auth) (STAR)

23369 (N-71-10405) RESULTS OF EXPERIMENTS TO SIMULATE RADIANT HEATING OF PROPELLANT IN A NUCLEAR LIGHT BULB ENGINE USING A DC ARC RADIANT ENERGY SOURCE. Klein, John F.; Roman, Ward C. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1970. Contract SNPC-70. 102p. (NASA-CR-111099; J-910900-1). NTIS.

The primary objective was to obtain high exit temperatures in the simulated propellant stream due to the absorption of large percentages of the incident thermal radiation. A high-power dc arc was used as the radiant energy source and argon seeded with carbon particles was used to simulate the propellant. Unseeded buffer layers were used to prevent coating of the transparent duct walls. Methods were developed for introducing micron-sized carbon seeds into the central region of a three-stream flow in an annular duct to simulate the propellant stream. Supporting research was also conducted to increase the mass attenuation coefficient of the seeded stream, to determine the optical properties of particle clouds, to develop seeded stream and buffer layer injection geometries that minimize seed coating of the duct walls, and to develop high-temperature measurement techniques for use with particle-laden streams. (auth) (STAR)

23370 (N-71-10413) EXPERIMENTAL INVESTIGATIONS OF SIMULATED-FUEL CONTAINMENT IN RF-HEATED AND UNHEATED TWO-COMPONENT VORTEXES. Jaminet, Jerome F. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1970. Contract SNPC-70. 112p. (NASA-CR-111101; J-910900-2). NTIS.

Experiments were conducted to determine the containment characteristics of radial-inflow vortexes for application to the nuclear light bulb engine. In these investigations, the amount of simulated fuel contained in two-component vortexes was measured for both heated and unheated (isothermal) vortex flows. In the vortex flows with heat addition, power was added to the flow by r-f induction heating of the gas within 1.26 in. dia by 2.8 or 3.5 in. long chambers. The simulated buffer gas, argon, was injected in a tangential (circumferential) direction either from the end walls or from the peripheral wall. The flow rate, plasma diameter, and power addition were such as to provide radial gradients of temperature of approximately 70,000 deg R/in. near the outer edge of the plasma. Xenon was employed as the simulated fuel and was injected into the vortex at several different locations. Spectroscopic techniques were used to determine the temperature distributions and the simulated-fuel partial pressures within the plasma. (auth) (STAR)

23371 (N-71-10431) ANALYTICAL STUDY OF THE SPECTRAL RADIANT FLUX EMITTED FROM THE FUEL REGION OF A NUCLEAR LIGHT BULB ENGINE. Krascella, N. L. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1970. Contract SNPC-70. 56p. (NASA-CR-111102; J-910904-1). NTIS.

A theoretical investigation was conducted to determine the spectral distribution of radiative flux emitted from the fuel region of a nuclear light bulb engine and, hence, the spectral radiative flux incident upon the transparent containment walls or upon the reflective end walls of such an engine. The analysis was performed for a specified engine configuration, for a specified nuclear fuel partial pressure distribution and for a total of 47 wave numbers. A total of six cases were calculated to investigate the effect on the spectral radiation flux of changes in total radiated flux, seed gas partial pressure, and end-wall reflectivity. The total radiated flux was changed from a reference value of 24,300 to 48,600 Btu/sq ft-sec. The effect of seed gases was examined by the addition of a mixture of 5 atm each of oxygen and nitric oxide. Wall reflectivity was examined by employing the spectral reflectivity of aluminum and silver in place of a zero-reflectivity wall employed in the reference case. (auth) (STAR)

23372 (N-71-10501) EXPERIMENTAL INVESTIGATION OF A HIGH-INTENSITY RF RADIANT ENERGY SOURCE TO SIMULATE THE THERMAL ENVIRONMENT IN A NUCLEAR LIGHT BULB ENGINE. Roman, Ward C. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1970. Contract SNPC-70. 77p. (NASA-CR-110909; J-910900-4). NTIS.

Experiments were continued to develop an intense radiant energy source capable of producing radiant energy fluxes approaching those expected in a full-scale nuclear light bulb engine. The test program was conducted using the UARL 1.2 megW radio frequency induction heater operating at approximately 5.5 mHz. RF energy was deposited in an argon plasma discharge contained within a radial-inflow vortex. The 2.24 in ID test chamber was formed by concentric, water-cooled, fused silica tubes and a symmetric pair of copper end walls spaced 2 in. apart. The effects of various geometric, flow and RF parameters on the power radiated from the plasma, the power deposited in the surrounding water-cooled transparent peripheral wall, and the power convected away from the plasma were investigated. Tests were conducted at pressures up to 19.2 atm. A maximum heat deposition rate per unit volume of 0.57 megW/cu in. was achieved in

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the steady-state, ellipsoidal plasma. The maximum radiant energy flux achieved at the edge of the plasma was 49 kW/sq in. which corresponds to an equivalent black-body radiating temperature (based on the plasma surface area) of 10,860 R. (auth) (STAR)

Process Heat and Desalination Reactors

23373 (PAECL/CHEM–118) DESALINATION: A BIBLIOGRAPHY FOR 1950–1969. Khan, Mehar Dil; Ashraf, Mohammad (Atomic Energy Centre, Lahore (Pakistan)). Jul 1970. 389p. Dep. NTIS (U. S. Sales Only).

Included are 1034 abstracts of references on desalination technology. A significant number of these references are concerned with the application of nuclear reactors for saline water distillation. (H.D.R.)

23374 NUCLEAR-ENERGY INDUSTRIAL COMPLEXES ENVISAGED. Miwa, Kimio (Prime Minister's Office, Tokyo). Ohm (Elec. Mag.); 57: No. 8, 27-33(Aug 1970). (In Japanese).

Nuclear-energy industrial complexes are envisaged on the basis of studies made in an ad hoc group in the Ministry of International Trade and Industry. The expectations for a nuclear-energy industrial complex as an aggregate of various technologies are first explained: building of a large industrial area, realization of an industrial complex without public hazards, and stabilized supply of an energy resource and its effective utilization. Then, envisaged models of the industrial complex are given. In one model, besides the electric power produced, crude oil is dissociated into the reducing gas ($CO + H_2$) and olefin by the high-temperature He gas from HTGR; the former for iron manufacturing and the latter for chemical industry. In another model, employing a PWR or BWR, chemical refinery and non-ferrous metals refining are incorporated. Finally, as problems toward the realization, the following are described: necessary technological development, utilities center, the site, complex scheme, etc. (Japan)

23375 ECONOMICS OF THE DESALINATION OF SEA WATER. Kurosaka, Takashi (Sasakura Engineering Co. Ltd., Tokyo). Genshiryoku Kogyo; 16: No. 6, 19-23(Jun 1970). (In Japanese).

The amount of precipitation in Japan is relatively large, as compared with other advanced countries in the world. Nevertheless, due to the dense population in a small land, the amount per capita is only $\frac{1}{5}$ of that in the United States. The advance in industries and in living standards, etc. present the problem of future desalination of sea water in Japan. The following, with emphasis on the economics, are described: the state of water supplies in Japan; sea-water desalination plants, dealing with the multi-stage flash type; the world state of desalination plants; economics of sea-water desalination (the reduction in fixed charges and in energy cost important for cut down of the water price, by-products, rational utilization of the produced water, etc.); and problems in technology (dealing with scale-formation, corrosion, etc.). (Japan)

23376 REALIZATION OF MULTI-PURPOSE UTILIZATION OF NUCLEAR REACTORS. Murata, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo; 16: No. 4, 18-22(Apr 1970). (In Japanese).

The following are described: An agro-industrial complex, an industrial complex, and their development. Combined utilization of nuclear power and steam, in Norway and Sweden (pulp and building-heating), in the United States (chemical industry) and in Germany are discussed. Desalination by nuclear energy in the United States and USSR are explained. Nuclear energy for high-temperature process industries, iron manufacture and chemical and ceramic industries, where high-temperature heat from nuclear reactors is essential is considered. (Japan)

23377 METHODOLOGICAL ASPECTS OF CALCULATING THE EFFICIENCIES OF ATOMIC DISTILLATION PLANTS. Koryakin, Yu. I.; Loginov, A. A.; Chernyaev, V. A. This paper was summarized in At. Energ. (USSR); 27: 47-8(Jul 1969) as paper No. 312/5090. (In Russian).

The uncertainty in the methodological nature of the problem has resulted in various approaches to the calculation of the engineering and economic efficiencies of industrial combinations. Presented are the bases for such calculations, expressions for the economic efficiency — the total expenditures — for dual-purpose atomic distillation plants, and analytic expressions for the distribution of the total expenditure among the individual types of production at atomic thermoelectric centers, which furnish heat for distillation. Much attention has been paid to the part of the expenditures representing the net production cost. Current methods for distributing the total production costs for the combined production of electrical energy and heat are reviewed, and their main features are analyzed. The following methods are discussed: the isolation method, the factor method, the physical method, the conservation method, the "exergetic" method, the thermodynamic method, and the underproduction method. The analysis permits formulation of a generalized method. This method, like the physical one, takes into account the structure of the overall cost of production at atomic thermoelectric centers; like the "exergetic" and thermodynamic methods, it makes the price of heat a function of its potential; and, finally, like the underproduction method, it takes into account the actual operation of the steam in the energetic cycle. (auth)

23378 MULTIPARAMETER OPTIMIZATION OF AN ATOMIC POWER PLANT WITH BASE-POINT DISTILLATION OF SEA WATER. Arsen'ev, Yu. D.; Radchenko, S. V.; Chernyaev, V. A. This paper was summarized in At. Energ. (USSR); 28: 418(May 1970) as paper No. 380/5557. (In Russian).

A method is presented to find the dimensionless complexes generalizing all the initial costs and technical indices which govern the reduced costs of dual-purpose plants. This method was compared with the dimensional computer-optimization program for an atomic power plant having a water-moderated water-cooled reactor, for the optimization of three parameters of the distillation installation: the number of evaporation stages, the temperature of the heating vapor, and the underheating of the sea water. (auth)

23379 NUCLEAR-BASED AMMONIA DESALINATION COMPLEXES: A NEW APPROACH FROM THE UNITED STATES. Nitrogen; No. 62, 32-4(Nov-Dec 1969).

The possibility of a combined desalination-ammonia synthesis complex based on nuclear energy is discussed. The possibilities for developing this type of fertilizer complex are promising since the production of phosphoric acid by the electric furnace method would also be extremely favourable in a location with low power cost. (Fuel Abstr.)

Marine and Portable Power Reactors

Refer also to abstracts 23232 and 23242.

23380 (AED-C–22-11) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 22. NUCLEAR SHIP PROPULSION. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Dec 1970. 26p. Dep. NTIS (U. S. Sales Only).

23381 (DOCKET-50238–79) N. S. SAVANNAH. Follow-up on Abnormal Occurrence Report: X-Ray Inspection of Pressurizer Safety Valves. (Maritime Administration, Washington, D. C.). 19 Mar 1971. 1p. Dep. NTIS.

23382 (HIT–465) THERMAL-HYDRAULIC ANALYSIS AND TECHNICAL SPECIFICATIONS FOR THE PM-3A TYPE 4 CORE. (Hittman Associates, Inc., Columbia, Md.). Nov 1970. Contract AT(30-1)-3775. 40p. Dep. NTIS.

A thermal-hydraulic analysis for the PM-3A Type 4 Replacement Core was performed to determine the effects of variations in core coolant flow, system pressure, core lifetime, and coolant temperature on the steady state burnout power level in the channel of the core having the greatest heat input and at the hot spot in that channel. The most limiting combination of the process variables examined was 2000 gpm, 1300 psia, 15 MW-yr, and 510°F, respectively. Several DNB correlations were used in the analysis and it was found that the Tong correlation was the most limiting. These limiting conditions were corrected for measurement and instrument uncertainties and these results are presented. Transient analyses for the Type 4 core were reviewed to determine the effect of postulated accidents on the thermal limitations. Specifically, a rod withdrawal accident from power was found to be the most detrimental with respect to possible burnout in the limiting channel. It was shown that the maximum heat flux during this rod withdrawal accident is less than that for steady state operation at the high power trip point. Therefore, no allowance was necessary for abnormal transients. The power level Safety Limit for the Type 4 Replacement Core was determined to be 157% of 11.27 MW(t). The Limiting Safety System Setting for power level was set at 122% of 11.27 MW(t) providing a large margin between the LS^3 and the uncertainty corrected Safety Limit power level of 147.5%. 9 references. (auth)

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23383 (N-71-10987) PRELIMINARY RESULTS ON 400-fps IMPACT TESTS OF TWO 2-ft-DIAMETER CONTAINMENT MODELS FOR MOBILE NUCLEAR REACTORS. Puthoff, R. L.; Dallas, T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct 1970. 21p. (NASA-TM-X-52915; E-6018). NTIS.

Impact tests at 400 ft/sec were conducted on two 2-foot diameter spherical models. The feasibility of containing fission products of a mobile reactor in the event of an impact is studied. The first model tested was hollow sphere, weighed 350 lb and the second, designated the metal shield impact model weighed 980 lb. Both models absorbed the energy of impact through deformation of the spherical vessels. No leaks were detected nor cracks observed on either model. (auth) (STAR)

23384 PHYSICAL CHARACTERISTICS OF THE SEVER MOBILE NUCLEAR POWER PLANT. Inyutin, E. I.; Matveenko, V. I.; Morozov, I. G.; (and others). This paper was summarized in At. Energ. (USSR); 26: 445(May 1969) as paper No. 283/5142. (In Russian).

The physics characteristics of two water-cooled, water-moderated reactors with consumable absorbers and active zones of the same size, 640 mm in diameter and 575 mm high, were studied. The reactors used the same fuel elements in square, 78 × 78-mm assemblies, with 49 (7 × 7) or 64 (8 × 8) pieces per assembly. The fuel elements were spaced at 11 or 9.5 mm in the assemblies; the ^{235}U charge was 23.6 kg or 31.6 kg. A rod with a consumable absorber (gadolinium or cadmium) could be used to replace any of the fuel elements. In addition, the stainless-steel assembly cover could be replaced with a boron-steel cover. The experimental results were analyzed in a two-group diffusion approximation, taking account of the neutron-thermalization effects. (auth)

23385 REACTOR CONTAINMENT VESSEL FOR THE NUCLEAR-POWERED SHIP, MUTSU. Shima, Eikichi (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo). Nippon Zosen Gakkaishi; No. 487, 12-16(Jan 1970). (In Japanese).

The design specifications, structure, materials, procedure of the construction, and tests for the Mutsu reactor containment vessel are described. (Japan)

23386 NUCLEAR-POWERED SHIP MUTSU. Fune No Kagaku; 23: No. 8, 45-61; 80(Aug 1970). (In Japanese).

Main features of the ship are: purpose, to obtain knowledge of the construction and navigation of a nuclear-powered ship and subsequently to be used as a freighter; dimensions of the ship, 130 m long, 19 m wide and 13.20 m deep; total tonnage, 8,350 T; hold capacity, 5,000 m^3; main engine, 10,000 ps, with navigational speed 16.5 Kn; reactor plant, an indirect cycle light water reactor with 36 MW(t); and the number of crew, 79. Nuclear-powered ship "Mutsu" is described in the following: the specifications, the general arrangement and ship construction, reactor plant, radiation control, safety countermeasures, and schedule of the construction. (Japan)

Production Reactors

23387 (CONF-700816-(Vol.2), pp 539-50) EFFECT OF SERVICE ON RETENTION OF IODINE BY ACTIVATED CARBON. Evans, A. G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

From 11. AEC air cleaning conference; Richland, Wash. (31 Aug 1970).

In Proceedings of the eleventh AEC air cleaning conference.

Activated carbon is installed in many reactor confinement systems to remove radioiodine from effluent gases in the unlikely event of a nuclear accident. For on-line confinement systems in which reactor building ventilation air and vent gases continuously pass through carbon beds, iodine retention and effective surface area of the carbon both decrease with increasing time. Coconut shell carbon used in the confinement systems at the Savannah River Plant was found to contain increasing amounts of trace gaseous pollutants (CO_2, NO, CO, H_2, and ethylene) with increasing service. The most significant pollutant was NO_2, which was formed in the air around the reactor tank. The NO_2 reacts with the carbon in the confinement system forming CO and NO, which destroy or occupy three active carbon sites for each NO_2 molecule reaching the carbon bed; thus, the iodine removal efficiency of the carbon is decreased. Used carbons can be partially regenerated by treatment with hot flowing air or vacuum heating, but complete regeneration was not accomplished even at temperatures up to 300°C. New or partially regenerated carbons can be artificially aged by passing NO_2-air mixtures through the carbon beds. Increasing NO_2 concentrations accelerate the aging process. Tests have been designed to simulate the temperature and humidity conditions calculated to occur in the Savannah River reactor confinement systems in the unlikely event of a reactor accident. These tests show that the carbon performance under accident conditions would become marginal after the carbon has been in service in the confinement system for about four years of normal reactor operation. 12 references. (auth)

Reactor Theory

Refer also to abstracts 23258 and 23334.

23388 (RT/ING-(70)11) THEORETICAL ANALYSIS OF A METHOD OF SIMULATION WITHOUT A PILE OF THE THERMAL GRADIENT OF A ROD IN A REACTOR. Cesaroni, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 30 May 1970. 56p. (In Italian). Dep. NTIS (U. S. Sales Only).

Induction heating was used in order to study thermal and mechanical fuel behavior in-pile simulating the parabolic temperature distribution of a fuel rod. The purpose was to find the radial temperature distribution corresponding to the maximum temperature zone of a UO_2 pellet. The influence of the various parameters on temperature distribution was also examined. An analogic method was defined which takes into account the non-linear aspect of the problem and allows a parametric study based on the assumption that the conditions are stationary. The experimental tests confirming the results obtained are reported. (12 references) (auth)

23389 γ-RADIATION OF FISSION PRODUCTS FOR A SHORT PERIOD OF SERVICE OF THE FUEL IN A NUCLEAR REACTOR. Stariznyi, E. S.; Breger, A. Kh. This paper was summarized in At. Energ. (USSR); 28: 492(Jun 1970) as paper No. 383/5611. (In Russian).

The strength of the γ-radiation arising from fission fragments in a nuclear reactor was calculated as a function of the time t elapsing after the acts of fission have ceased for cases in which the nuclear fuel has only been in the active zone of the reactor for a short time t_r ($t_r \leq 1$ h). In plotting the time dependence of the intensity of the γ-radiation arising from the fragments associated with a single act of fission, the results of an earlier paper were used for the range $t \lesssim 1.5 \cdot 10^3$ sec and other results for the range $t \gtrsim 2.0 \cdot 10^3$ sec. (auth)

23390 TENSOR FORM OF THE NEUTRON-TRANSPORT EQUATION WITH APPLICATION TO FINITE DIFFERENCING. Drawbaugh, D. W. (Westinghouse Astronuclear Lab., Pittsburgh). Nucl. Sci. Eng.; 44: 58-65(Apr 1971).

The transport equation is written in conservation form as a tensor equation, div MN + σN = S, in the five-dimensional position plus direction Riemann space. The equation is finite differenced by the integration method using the divergence theorem. (auth)

23391 ALTERED DIFFUSION THEORY BASED ON THE DOUBLE P-O APPROXIMATION FOR ALL GEOMETRIES. Paveri-Fontana, Stefano L.; Amster, Harvey (Univ. of California, Berkeley). Nucl. Sci. Eng.; 44: 44-57(Apr 1971).

The double spherical harmonics method was considered applicable only if two conditions are fullfilled: (a) the directions of the assumed angular discontinuities could be assigned a priori by symmetry, and (b) at every boundary surface, these directions lie in a tangent plane. The DP-0 approximation is reformulated to cover all situations; for some new ones, the accuracy is predictably better than that from the P-1 approximation. The directions of the angular discontinuity now have to be calculated, but a straightforward generalization of the usual derivation fails to furnish such a procedure. This generalization also retains a former uncertainty about how much of a delta function is on each side of the angular discontinuity. A variational principle is used as one way to settle both of these issues. Anisotropic scattering is allowed. Remarkably, the completed formulation differs from ordinary diffusion theory, including boundary conditions, only in the definition of the diffusion coefficient. A standard diffusion theory calculation can accommodate whichever type of theory is preferred in any particular region of a single problem; the adjustment is made merely by assigning the corresponding diffusion coefficient there. The variational principle implies that the delta function should be divided evenly into two parts at the discontinuity. However, this division is not a mathematically inherent property of the delta function, as sometimes thought, and other formulations for spherical and cylindrical geometries have placed the delta function entirely in the forward hemisphere of directions. Examples showing superior accuracy and physical interpretations supported that choice, but they are matched by other examples favoring different divisions. 22 references. (auth)

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Kinetics

23392 (ANL–7713) ARC SYSTEM NEUTRONICS INPUT PROCESSOR. Kovalsky, E. A.; Neal, D. E. (Argonne National Lab., Ill.). Jan 1971. Contract W-31-109-eng-38. 390p. Dep. NTIS.

The documentation of the ARC System modules GNIP (NUI002) and CPGEOM (AJC006) is presented. NUI002 reads and processes the neutronics module independent BCD card images which define reactor geometry, mesh structure, region and composition assignments, boundary conditions, problem type, criticality search specifications and external source data. AJC006 is a utility module which copies the ARC system interface data set GEOM from one logical unit to another. (auth)

23393 (GULF-RT–10195) CAGE-BIRD-SPEC: A PACKAGE FORTRAN-V SYSTEM FOR THE REDUCTION AND ANALYSIS OF NEUTRON TIME-OF-FLIGHT SPECTRA. d'Oultremont, P.; Houston, D.; Young, J. C. (Gulf Radiation Technology, San Diego, Calif.). 18 Nov 1970. Contract AT(04-3)-167. 130p. Dep. NTIS.

Three FORTRAN V codes, namely CAGE, BIRD, and SPEC, which are used for the reduction and analysis of neutron time-of-flight spectra obtained in fast and thermal subcritical reactors, are described. Neutron time-of-flight spectra of subcritical reactors have to be corrected for neutron emission time and detector distortions as well as for the usual perturbations due to background and time analyzer dead time. All these corrections are performed by SPEC. This code reads the experimental data (signals and backgrounds), corrects them for the dead time of the recording system and then produces a net signal. As a second step, SPEC accepts a correction factor which, applied to the time-of-flight spectrum, removes the distortions due to neutron emission time and detector efficiency. Finally, SPEC edits the fully reduced data and the associated statistical error and groups them into the energy mesh requested by the user. The correction factor used by SPEC is computed by BIRD. This code computes the full time-energy dependent response of the pulsed system and, from then on, is able to calculate the distortion suffered by the time-of-flight spectrum due to the finite neutron emission time. The correction factor provided by BIRD also contains the energy-dependent detector efficiency and flight path transmission. Since the relevance of the emission time correction depends rather heavily on the correct computation of the system reactivity (or in matching the measured dieaway, or both), preliminary calculations are performed with the code CAGE (which is also embodied in BIRD as the subroutine which calculates the time-energy-dependent behavior of the neutron flux). CAGE is used to adjust geometrical parameters to achieve the right reactivity level and to compute the time-dependent response of various neutron detectors in order to ascertain that the experimentally measured dieaway is reproduced by the calculation. When this result is achieved, the right parameters are fed into BIRD along with the detector efficiency and flight path transmission table and the correction factor is computed. (auth)

23394 (IAE–1964) THEORY OF THE CRITICALITY OF A REACTOR DURING OSCILLATIONS OF THE FUEL DENSITY (AN ADIABATIC APPROXIMATION). Novikov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1970. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

In one-group approximation an adiabatical theory is presented for calculation of the additional reactor reactivity appearing when the gaseous fuel density oscillations are exited. It is shown that in case of $[(\Delta\rho/\rho_0)/(K_\infty - 1)] \ll 1$ [$(\Delta\rho/\rho_0)$ – relative oscillations amplitude] the magnitude ΔK_{eff} appears as a second order effect with $\Delta\rho/\rho_0$; on the other hand, when $[(\Delta\rho/\rho_0)/(K_\infty - 1)] \gg 1$ the magnitude ΔK_{eff} is directly proportional to $\Delta\rho/\rho_0$. The dependance of the ΔK_{eff} on oscillations frequency is obtained for the case of $[(\Delta\rho/\rho_0)/(K_\infty - 1)] \ll 1$. The dependance of ΔK_{eff} on sound velocity in fuel and on the number of oscillations half-waves keeping within reactor size is analyzed. The experimental possibility of modelling these effects by means of surface gravitational waves excitation in liquid fuel in reactor horizontal canals is discussed. 3 references. (auth)

23395 (JAERI–1196) CLUP 77: A FORTRAN PROGRAM OF COLLISION PROBABILITIES FOR SQUARE CLUSTERED ASSEMBLY. Tsuchihashi, Keiichiro (Japan Atomic Energy Research Inst., Tokyo). Jul 1970. 21p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The collision probabilities in a multi-region (≤120) square assembly consisting of clustered rods of infinite height are calculated by a Fortran program "CLUP 77" by a numerical double integration. The assembly is divided into a number of pillars with a rectangular cross section. A rectangular pillar may contain a nest of concentric annuli of different materials. The assembly must be symmetric both bilaterally and diagonally. A region consists of one or several pillars (with the shapes rectangular, annular, etc.). The outer boundary of the assembly may be reflective or vacuum. Therefore an array of fuel rods, a cruciform control rod and a poison curtain in the assembly can be treated without smearing. When and only when one group calculation with a fixed source is required, the flux distribution is calculated by the iterative technique, and the reaction rates (absorption, absorption + leakage, collision) at each region and by each material and averaged cross sections are obtained. 10 references. (auth)

23396 (LFEN-NI,–48-a) CALCULATION OF THE VARIATION WITH TIME OF THE NEUTRON DENSITY IN A REACTOR AFTER AN ABRUPT CHANGE IN REACTIVITY. Oliveira, Jaime M. Costa (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 14p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The LFEN-FR6 program for calculating the spatial neutron flux distribution variation with time following a reactivity perturbation in a point model reactor is described. The program is written in FORTRAN IV for the IBM 360/50. The mathematical formulation of the problem, the program input, and a sample output are presented. (H.D.R.)

23397 (LFEN-NI–58-a) CORRELATION METHODS IN THE STUDY OF NUCLEAR REACTOR. Oliveira, Jaime M. Costa (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1970. 27p. (In Portuguese). (CONF-700943–1). Dep. NTIS (U. S. Sales Only).

From Symposium on Theory of Information and of Systems, Lisbon, Portugal.

A method for the study of the transfer function of a nuclear reactor, based on the intercorrelation of the responses of two neutron detectors, is described. The signals are subjected to a surface diagram and the results are fed to a computer together with a program for the calculation of the correlation function and the spectral density of interaction. The advantages of the variation of the intercorrelation method adopted is shown. (tr-auth)

23398 (UCRL–20215) PARTITION OF NUMBERS AND APPLICATION TO HIGHER DERIVATIVES OF COMPOSITE FUNCTIONS. Routti, Jorma T.; Szeless, Andreas (California Univ., Berkeley. Lawrence Radiation Lab.). 30 Sep 1970. Contract W-7405-eng-48. 12p. Dep. NTIS.

Formulae and algorithms are presented for computing the partitions and the number of partitions of positive integers. Results are given and applied through an equivalent form of the partition problem to the determination of higher derivatives of composite functions, in particular to the probability-generating functions in reactor noise analysis. 9 references. (auth)

23399 (UJV–2397.R,F.) CRITICAL CONDITION OF A HETEROGENEOUS REACTOR IN MULTI-GROUP APPROXIMATION. Rocek, J.; Miasnikov, A. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1970. 11p. (In Czech). NTIS (U. S. Sales Only).

A summary is given of the starting assumptions and the methods used to calculate the critical condition of a large bare heterogenous reactor by means of the heterogeneous method, as published by various authors. Particular attention is given to the effect of the fine structure of thermal neutron sources due to moderation. (INIS)

23400 (UJV–2398.RF.) CALCULATION OF ISOTOPIC REACTIVITY CHANGES BY PERTURBATION THEORY IN THE MULTIGROUP DIFFUSION APPROXIMATION. Tinka, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [nd]. 15p. (In Slovak). NTIS (U. S. Sales Only).

Formulas are given for the calculation of reactivity after insertion of various substances into the reactor, and the EREIS program set up in the GIER–ALGOL III code for the GIER computer is described. The program was employed to perform physics computations for the ZRR experimental fast reactor. Some of the results are given in tables and graphs. (INIS)

23401 LIMITING RATIO OF MAXIMUM THERMAL-NEUTRON FLUX TO REACTOR POWER. Kochenov, A. S. This paper was summarized in At. Energ. (USSR); 26: 449-50(May 1969) as paper No. 292/5044. (In Russian).

An important parameter in the study of a reactor, along with the absolute value of the maximum thermal-neutron flux, is the ratio of the maximum thermal-neutron flux to the reactor power (Φ_{max}/N). For a homogeneous active zone, the ratio of the average thermal-neutron flux to the reactor power is inversely proportional

to the ^{235}U charge. The minimum critical ^{235}U charge is attained in reactors with heavy-water moderators and reflectors and in reactors with ordinary-water moderators and beryllium reflectors. In these reactors, we have $\Phi_{max}/N \approx 10$ neutrons/cm^2 · sec · kW. Values of Φ_{max}/N and k_∞ required for criticality in water-cooled, water-moderated reactors with ordinary-water traps and beryllium reflectors are presented. (auth)

23402 NUMERICAL DETERMINATION OF NEUTRON FLUX IN NONSTATIONARY AS WELL AS STATIONARY PROCESSES IN NUCLEAR REACTORS. Otcenasek, P. (Technical Univ., Prague). Acta Polytech. (Prague), IV; No. 1, 63-79(1969).

Space distribution of the neutron flux in a multigroup model is numerically solved by means of a zone analysis based on the flux balance in zones and the influence of all zones within the reactor, where the transport retardation is neglected and delayed neutrons are considered. It seems possible to determine the influence of large changes in boundary conditions and in parameters on the deviation from the stationary state. The method can be used to solve spatial kinetic problems in the field of nuclear reactors and to find the space distribution of neutron flux in stationary states. (NSA of Czech)

23403 RECONSTRUCTION OF A FAST NEUTRON REACTOR SPECTRUM FROM THRESHOLD DETECTOR DATA. Chernoyarskii, A. A.; Medik, V. S.; Zaitov, A. M.; Kukhtevich, V. I. This paper was summarized in At. Energ. (USSR); 26: 371-2 (Apr 1969) as paper Nos. 276/5058 and 277/4782. (In Russian).

An improvement in Dierckx's method for reconstructing a fast neutron spectrum in the 1–3 MeV range by using the exponential approximation is presented. Computer calculations were made of functions of the exponential approximation parameters. The calculations used the actual energy dependence of the cross sections. The functions were calculated for values of the exponent from 0 to 2.4 which enables one to reconstruct all possible neutron spectra occurring in actual reactor cores. As a result of studying several sets of threshold detectors it was established that the set $^{237}Np(n,f)$, $^{238}U(n,f)$, $^{27}Al(n,p)$, $^{56}Fe(n,p)$, and $^{27}Al(n,\alpha)$ yields a very stable solution with respect to errors in the experimental data. The inclusion of $^{237}Np(n,f)$ and $^{238}U(n,f)$ permits the low-energy limit of the reconstructed spectrum to be extended to 0.5 MeV. This method was used to reconstruct the spectra of two different reactors which had been reconstructed by other methods. Satisfactory agreement of the results shows that the proposed method may be very successfully used to reconstruct fast neutron reactor spectra by using a small number of detectors. (auth)

23404 OPTIMIZATION OF PARAMETERS OF TWO-GROUP APPROXIMATION OF KINETICS EQUATIONS BY THE METHOD OF LOGARITHMIC FREQUENCY RESPONSE. Prikot, K. N.; Uspenskii, V. K. This paper was summarized in At. Energ. (USSR); 28: 491(Jun 1970) as paper No. 393/5572. (In Russian).

A method for determining the optimum parameters in the case of a two-group approximation of kinetics equations for a zero-power reactor bringing about agreement between the logarithmic amplitude-dependent and phase-dependent frequency response of six-group and two-group models over the entire frequency range, and to close precision, is proposed. It is shown that the half-life of one of two generalized groups is a constant for all lifetimes of prompt neutrons l^*, in thermal fission and also in fast fission in the range $5 < \delta = (\beta/l^*) \leq \infty$. Dependences were derived for the other parameters of the two-group model as functions of parameters of the six-group model. The logarithmic frequency response plotted for $\delta = 140$ agrees over the entire range of frequencies with a maximum amplitude error ~0.7 dB and a maximum phase error ~6°. A comparative analysis of the transient response to stepwise reactivity perturbations was carried out. The numerical results obtained refer to ^{235}U, but the method used to obtain them can be extended to other types of nuclear fuel. (auth)

23405 IMPROVED SPATIAL DIFFERENCING FOR THE SOLUTION OF SPACE–TIME PROBLEMS ARISING FROM THE MOVEMENT OF REACTOR MATERIALS. Yasinsky, J. B.; Foulke, L. R. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng.; 44: 72-85(Apr 1971).

It is shown that the use of the standard spatial-differencing method when applied to space-time diffusion problems arising as the materials within a reactor are displaced can result in solutions which display a nonphysical time dependence. This irregular time dependence occurs when the spatial mesh and timestep are such that it takes several timesteps for a movable material interface to move between two spatial meshpoints. New spatial difference equations, based on a specified piecewise polynomial flux behavior between meshpoints, are developed for the space-time group diffusion equations. Numerical studies show that these new difference equations eliminate the nonphysical time dependence of the solution for movable material problems. In addition, it is shown that for such problems the solutions resulting from the new difference equations are almost as accurate as solutions obtain obtained using the standard difference equations with a much finer spatial mesh. (auth)

23406 DETERMINATION OF STABILITY DOMAINS IN NONLINEAR POINT REACTOR DYNAMICS. Ziskind, Richard; Kastenberg, William E. (Univ. of California, Los Angeles). Nucl. Sci. Eng.; 44: 86-94(Apr 1971).

The stability problem for point kinetics models described by a set of nonlinear differential equations is treated by conversion to a set of Volterra integral equations. The kernels appearing in the resultant set are classified as to monotone behavior and comparison theorems are presented for the various classifications. The comparison theorems are utilized to calculate solution bounds and stability domains for three systems of practical interest: prompt power feedback, single temperature with prompt power coefficient, and the Hansen–Fuchs model. It is shown that similarity transformations are useful for enlarging the stability domain. An iteration procedure is also developed for a particular class of integral operators. This procedure is useful for finding convergent bounds for the true system behavior. 9 references. (auth)

23407 COMMENT ON SUBCRITICAL REACTIVITY FROM REACTOR NOISE. Albrecht, Robert W. (Univ. of Washington, Seattle). Nucl. Sci. Eng.; 44: 112(Apr 1971).

23408 ANALYSIS OF PSEUDO-MODE IN SPACE-DEPENDENT NEUTRON THERMALIZATION. Matsumoto, Takaaki (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: 107-10(Feb 1971).

The spatial distribution of neutron fluxes in small crystalline moderators is analyzed with consideration of energy-dependent buckling. The fluxes are classified on the basis of the number of inelastic scatterings. It is shown that the spatial distribution in a small moderator that has only the pseudo-mode and no discrete eigen-mode can be represented by consideration of energy-dependent buckling. (10 references) (H.D.R.)

23409 SUBCRITICAL REACTIVITY FROM REACTOR NOISE. Szeless, Andreas; Ruby, Lawrence (Univ. of California, Berkeley). Nucl. Sci. Eng.; 44: 110-12(Apr 1971).

An expression for the subcritical reactivity of a steady-state reactor in terms of measurable noise quantities is formulated. Delayed neutrons are included in the analysis, and no measurement at delayed critical operation is required to calculate the reactivity. (H.D.R.)

Experimental Applications

23410 (BAW–3647-20) PHYSICS VERIFICATION PROGRAM. PART III, TASK 4. Summary Report. Baldwin, M. N.; Stern, M. E. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Mar 1971. Contract AT(30-1)-3647. 39p. Dep. NTIS.

Task 4 of the program consisted principally of a series of experiments to measure the effect of lattice heterogeneities on reactor physics parameters. The facility used was a water moderated critical assembly in a 5 by 6.5 foot aluminum tank. Poison, neutral, and moderating materials were used to produce heterogeneities for study. The facility and experiments are described and the measurement results are presented. 8 references. (H.D.R.)

23411 (RT/FI–(70)29) SURVEY OF ADVANCEMENTS IN NEUTRON STATISTICS AND REACTOR-KINETICS TECHNIQUES AT LFCR (1967–69). Pacilio, N. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). 1970. 35p. Dep. NTIS (U. S. Sales Only).

Progress in neutron-statistics and reactor-kinetics techniques at LFCR (Laboratorio Fisica e Calcolo Reattori) CSN of Casaccia is summarized covering the three-year period from 1967 to 1969. Part of the work was realized in cooperation with Argonne National Laboratory, Battelle Memorial Institute Pacific Northwest Laboratory and the United States Atomic Energy Commission, U.S.A. A comprehensive bibliography is given for specific details on the single sections of the survey. (19 references) (auth)

23412 MEASUREMENT OF THE FAST NEUTRON DISTRIBUTION IN A CELL OF A URANIUM–GRAPHITE REACTOR WITH A RHODIUM THRESHOLD DETECTOR. Bushuev, A. V.; Bortsov, V. G.; Duvanov, V. M. This paper was summarized in At. Energ. (USSR); 28: 420(May 1970) as paper No. 384/5378. (In Russian).

The apparatus and the method used to make measurements with a rhodium detector are described. The background sources

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(^{104m}Rh) and the impurities (^{192}Ir and ^{194}Ir) are discussed. It is shown that in certain cases the use of cadmium to suppress the background of thermal neutrons leads to errors. The experiments were performed in a graphite assembly with nine natural uranium rods placed in a cavity in the reflector of the F-1 reactor at the Institute of Atomic Energy. Results are presented of measurements in a dry cell and in a cell with layers of water 2 and 11 mm thick around the fuel elements. (auth)

23413 REACTOR KINETIC PARAMETERS OF LATTICES OF PLUTONIUM AND URANIUM IN WATER. Uotinen, V. O.; Lauby, J. H.; Stinson, W. P.; Dwivedi, S. R. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Nucl. Sci. Eng.; 44: 66-71(Apr 1971).

The ratio β_{eff}/l was deduced from reactor noise measurements in several uniform light-water lattices in the Plutonium Recycle Critical Facility. These lattices included one in which the fissile material was slightly enriched uranium, one in which the fissile material was plutonium, and five lattices in which the fissile material contained both uranium and plutonium. These measurements supply a set of experimental data over a range of plutonium enrichments that are applicable to plutonium recycle situations in thermal reactors. The measured values of β_{eff}/l range from 33 ± 3 sec^{-1} for a lattice of Al–Pu rods to 153 ± 8 sec^{-1} for a lattice of UO_2 rods. Calculated values of β_{eff}/l, obtained with a straightforward reactor design calculational method, are in good agreement with measured values. 22 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 20925, 21231, 21258–21260, 21295, 21300, 21305, 21376, 21466, 21547, 22006, 22007, 22033, 22054, 22069, 22070–22074, 22077, 22089, 22119, 22122, 22137, 22204, 22207, 22208, and 23231.

23414 (CEA-CONF-1731) TESTS OF HYDRAULIC AND PNEUMATIC FAILURES IN PRESTRESSED CONCRETE VESSELS. Costes, D.; Avet Flancard, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 9p. (In French). (CONF-701207-1). Dep. NTIS (U. S. Sales Only).

From Meeting on prestressed concrete vessels for nuclear reactors; Delft, Netherlands (4 Dec 1970).

The ultimate consequences of armature corrosion are examined. Particular attention is given to the prior warnings taking place before the explosive rupture. Preliminary tests (1964–1967) indicated that rupture due to armature corrosion at the pressures normally used would be preceded by warning signs such as noise and deformation. An attempt was made to investigate the possibility of zone corrosion or more generalized corrosion of the armatures, without the appearance of warning signs. The test program is described. The preliminary tests of this new program are planned for March 1971. (France)

23415 IMPROVEMENTS RELATING TO SUSPENSION MEANS FOR THE CONTROL RODS OF NUCLEAR REACTORS. Dean, John Raymond; Wilcox, William Henry Graham (to A. Reyrolle and Co. Limited). British Patent 1,221,690. 3 Feb 1971. Filed 22 Oct 1968.

The invention concerns an improved form of suspension arrangements for the neutron-absorbing control rods of nuclear reactors in which the power developed is regulated by the insertion of these rods. The suspension arrangement comprises an open-link chain, one end of which is attached to the head of a control rod or group of rods as a suspension member, the chain passing up from the rods and around a motor-driven driving sprocket and thence hanging down into a chain locker on the floor. The other end of the chain may be secured in the chain locker, preferably to a resiliently-mounted anchorage to provide a shock-absorbing effect when the control rod or group of rods reaches the lower end of its travel with the chain fully extended. The driving sprocket is coupled through a drive mechanism incorporating a releasable clutch to a hoist driving motor, by means of which the driving sprocket can be turned to drive the chain or lower the control rods. (UK)

23416 NUCLEAR REACTOR FUEL ROD SPACER. Lass, James Lloyd; Ross, Wilfred Thomas; Venier, Dominic Ambrose (to General Electric Co.). British Patent 1,222,238. 10 Feb 1971. Priority date 26 Jun 1967, United States.

REACTOR FUEL ELEMENTS—spacers for, configuration of zirconium alloy support and divider means and Inconel spring assemblies as (H.D.R.)

23417 NUCLEAR REACTOR FUEL CHARGE-DISCHARGE INSTALLATION. Meunier, Jean (to Commissariat a l'Energie Atomique). British Patent 1,221,020. 3 Feb 1971. Priority date 21 Apr 1967, France.

REACTOR LOADING MACHINES—design of pressure vessel enclosed, for gas cooled reactors

REACTORS, GAS COOLED—fuel element loading installation for, design of pressure vessel enclosed (H.D.R.)

23418 CONTROL AND SAFETY RODS FOR NUCLEAR REACTORS. Agazzi, Alberto; Sergio, Amando Broggi; Ghiurghi, Luciano (to EURATOM). British Patent 1,221,010. 3 Feb 1971. Priority date 5 Apr 1968, Belgium.

REACTOR CONTROL SYSTEMS—design of hollow tube, with means for introduction of gaseous and liquid poisons (H.D.R.)

23419 FAILED ELEMENT DETECTION IN NUCLEAR REACTORS. HOT DETECTORS AND THE ASSOCIATED ELECTRONIC CIRCUITS. Bouchez, Henri; Laxague, Jean (Alcatel, Paris). Ind. At.; 14: No. 9/10, 47-55(Sep-Oct 1970). (In French).

Burst slugs are detected in French nuclear power stations by an electrostatic collection method and by the counts obtained from the fission products present in the cooling liquid of the fuel slug. A prototype detector functioning with hot gas is described with its associated circuitry constructed according to the CEA module standards. Various tests were carried out on this apparatus at Chinon using the burst-slug-detector installation of the EDF reactor. This reactor is equipped with cold-type detectors. Hot- and cold-type detectors are compared, and the possibility of developing an intermediate temperature detector considered. (auth) (France)

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GENERAL

23420 (AEC-tr-7027/11) NUKLEONIKA, Translation of Nukleonika; 14: 1037-1184(1969). 134p. (TT-69-50012/11). Dep. NTIS.

23421 (AEC-tr-7027/12) NUKLEONIKA, Translation of Nukleonika; 14: 1185-1262(1969). 75p. (TT-69-50012/12). Dep. NTIS.

23422 (ANL-Trans-877) PEROXIDASE AND CATALASE ACTIVITY IN OXYGEN UNDER PRESSURE. Efuni, S. N.; Mikhailov, Yu. E.; Fokina, T. S.; Shimkevich, L. L. Translated for Argonne National Lab., Ill. from Eksp. Khir. Anesteziol.; 15: 63-5(May-Jun 1970). 5p. Dep. NTIS.

23423 (ANL/ES-CEN-1002) REDUCTION OF ATMOSPHERIC POLLUTION BY THE APPLICATION OF FLUIDIZED-BED COMBUSTION. Annual Report, July 1969-June 1970. Jonke, A. A.; Carls, E. L.; Jarry, R. L.; Anastasia, L. J.; Haas, M.; Pavlik, J. R.; Murphy, W. A.; Schoffstoll, C. B.; Vargo, G. N. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 87p. Dep. NTIS.

23424 (BDX-613-316) MECHANICAL PRODUCTS QUARTERLY. (Bendix Corp., Kansas City, Mo.). Feb 1971. Contract AT(29-1)-613. 128p. Dep. NTIS.

23425 (BDX-613-333) PRESSURE AND TEMPERATURE GRADIENTS IN TRANSFER MOLDING OF ELECTRONIC ASSEMBLIES. Lewis, F. H. (Bendix Corp., Kansas City, Mo.). Apr 1970. Contract AT(29-1)-613. 154p. Dep. NTIS.

23426 (BNWL-SA-3279) NEW DEVELOPMENTS IN ULTRASONIC COATING THICKNESS MEASUREMENTS. Newman, D. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 18 May 1970. Contract AT(45-1)-1830. 11p. (CONF-700435-2). Dep. NTIS.
From 15. meeting of the NDT groups of the AEC weapons program; Miamisburg, Ohio (8 Apr 1970).

23427 (BNWL-SA-3289) NONDESTRUCTIVE TESTING APPLICATIONS OF THERMAL TRANSDUCERS. McCullough, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 18 May 1970. Contract AT(45-1)-1830. 13p. (CONF-700435-1). Dep. NTIS.
From 15. meeting of the NDT groups of the AEC weapons program; Miamisburg, Ohio (8 Apr 1970).

23428 (COO-1198-801) VACANCY MIGRATION ENERGY IN ALUMINUM: A DETERMINATION BY NUCLEAR MAGNETIC RELAXATION. Sun, Cherng-Yuan (Illinois Univ., Urbana). Feb 1971. Contract AT(11-1)-1198. 144p. Dep. NTIS.
Thesis.

23429 (COO-1222-43) GAS CHROMATOGRAPHIC STUDIES OF RAPID REPEATED INJECTIONS OF SAMPLES INTO A COLUMN. Macnaughtan, Donald Jr.; Rogers, L. B. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). [1970]. Contract AT(11-1)-1222. 27p. Dep. NTIS.

23430 (COO-1224-44) COMPUTER-CONTROLLED GAS CHROMATOGRAPH CAPABLE OF "REAL-TIME" READOUT OF HIGH-PRECISION DATA. Swingle, R. S.; Rogers, L. B. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). [1970]. Contract AT(11-1)-1222. 33p. Dep. NTIS.

23431 (COO-1495-15) MOVEMENT OF STRONTIUM THROUGH THE SOIL TO THE PLANT ROOT MEMBRANE. Technical Progress Report, June 1, 1970-May 31, 1971. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1495. 30p. Dep. NTIS.

23432 (COO-1794-7) CYCLIC FATIGUE OF BRITTLE MATERIALS. Progress Report. Broutman, L. J.; Gaggar, S. K. (Illinois Inst. of Tech., Chicago). 30 Jan 1971. 27p. Dep. NTIS.

23433 (COO-2003-3) SURVEY OF PHYTOPLANKTON PRODUCTIVITY AND NUTRIENTS IN LAKE MICHIGAN AND LAKE SUPERIOR. Schelske, Claire L.; Callender, Edward (Michigan Univ., Ann Arbor. Great Lakes Research Div.). [1969]. 28p. (CONF-700434-1). Dep. NTIS.
From 13. conference for Great Lakes research; Buffalo, N. Y. (1 Apr 1970).

23434 (COO-2032-4) DENSITY DISTRIBUTION MEASUREMENTS IN RAREFIED GASES CONTAINED BETWEEN PARALLEL PLATES AT HIGH TEMPERATURE DIFFERENCES. Alofs, Darryl J.; Flagan, Richard G.; Springer, George S. (Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering). [nd]. 5p. (CONF-700644-1). Dep. NTIS.
From 7. international symposium on rarefield gas dynamics; Pisa, Italy (29 Jun 1970).

23435 (COO-2101-1) SYNTHESIS OF DNA CONTAINING URACIL OR 5-HYDROXYMETHYLURACIL DURING BACTERIOPHAGE INFECTION OF BACILLUS SUBTILIS. Technical Progress Report. Price, Alan R. (Michigan Univ., Ann Arbor. Dept. of Biological Chemistry). 15 Jan 1971. Contract AT(11-1)-2101. 8p. Dep. NTIS.

23436 (GEAP-10248) TWO-PHASE FLOW AND HEAT TRANSFER IN MULTIROD GEOMETRIES: A STUDY OF THE LIQUID FILM IN ADIABATIC AIR-WATER FLOW WITH AND WITHOUT OBSTACLES. Shiralkar, B. S. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct 1970. Contract AT(04-3)-189. 72p. Dep. NTIS.

23437 (GEPP-81) FORTRAN PROGRAM FOR PASS-FAIL DECISIONS. Rich, J. C. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). 17 Dec 1970. Contract AT(29-2)-656. 17p. Dep. NTIS.

23438 (IS-T-421) MECHANICAL PROPERTIES OF SOME NICKEL-COPPER AND NICKEL-COPPER-CARBON ALLOYS BELOW 0.35 T_m. Zerwekh, Robert Paul (Ames Lab., Iowa). Nov 1970. Contract W-7405-eng-82. 123p. Dep. NTIS.
Thesis.

23439 (IS-T-422) EFFECT OF PRECIPITATION ON THE MECHANICAL PROPERTIES OF THE Cu-1.9 PERCENT Co AND THE Cu-2 PERCENT Co-6 PERCENT Zn SYSTEMS. Olson, Norman James (Ames Lab., Iowa). Nov 1970. Contract W-7405-eng-82. 123p. Dep. NTIS.
Thesis.

23440 (IS-T-428) EFFECT OF RANDOM EXPERIMENTAL ERROR IN VAPOR-LIQUID EQUILIBRIUM DATA ON THERMODYNAMIC CONSISTENCY. Ulrichson, Dean LeRoy (Ames Lab., Iowa). Nov 1970. Contract W-7405-eng-82. 150p. Dep. NTIS.
Thesis.

23441 (IS-T-439) THE CRYSTAL STRUCTURE OF QUINOLINIUM NONABROMOANTIMONATE(V), $(C_9H_7NH)_2Sb^VBr_9$ AND THE REFINEMENT OF THE MOLECULAR STRUCTURE OF BETA-PICOLINE-N-OXIDE FUMARIC ACID ADDUCT. McAfee, Elwin Ray (Ames Lab., Iowa). Nov 1970. Contract W-7405-eng-82. 33p. Dep. NTIS.
Thesis.

23442 (IS-T-440) INTERNAL FLOW PATTERNS OF FORMING LIQUID DROPS. Weathers, Philip Wayne (Ames Lab., Iowa). Nov 1970. Contract W-7405-eng-82. 45p. Dep. NTIS.
Thesis.

23443 (IS-T-441) GROWTH OF ZINC SINGLE CRYSTALS AT A CONTROLLED RATE FROM THE MELT. Wienert, Robert John (Ames Lab., Iowa). Feb 1971. Contract W-7405-eng-82. 36p. Dep. NTIS.
Thesis.

23444 (ISS-70/14) TEMPERATURE-MODULATED SPECTROSCOPY OF THE EXCITONIC REGION OF GaSe. Balzarotti, A.; Grandolfo, M.; Somma, F.; Vecchia, P. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 23 May 1970. 45p. (In Italian). Dep. NTIS (U. S. Sales Only).

23445 (LA-tr-71-8) TIME-DEPENDENT CONVERSION FORMULAS FOR HETEROGENEOUS REACTIONS AT THE INTERFACES OF SOLID BODIES. 1. DEVELOPMENT OF THE MATHEMATICAL METHOD AND THE DERIVATION OF THE SURFACE CONVERSION FORMULAS. Mampel, K. L. Translated for Los Alamos Scientific Lab., N. Mex., from Z. Phys. Chem. (Leipzig), A; 187: 43-57(1940). 14p. Dep. NTIS.

23446 (LA-tr-71-9) TIME-DEPENDENT CONVERSION FORMULAS FOR HETEROGENEOUS REACTIONS AT THE INTERFACES OF SOLID BODIES. 2. TIME-DEPENDENT CONVERSION FORMULAS FOR A POWDER OF SPHERE-SHAPED

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PARTICLES. Mampel, K. L. Translated for Los Alamos Scientific Lab., N. Mex., from Z. Phys. Chem. (Leipzig), A; 187: 235-40(1940). 14p. Dep. NTIS.

23447 (LA-tr-71-15) HYDROGEN PRESSURE IN VACUUM SYSTEMS WITH CRYO-CONDENSATION PUMPS. Grosse, G.; Messer, G. Translated for Los Alamos Scientific Lab., N. Mex., from 3rd International Cryogenic Engineering Conference, West Berlin, Germany, May 25–27, 1970. 12p. (CONF-700522-3). Dep. NTIS.

23448 (LI–42) EFFECTS OF AGE, WEIGHT, STRAIN, AND ANESTHESIA UPON THE BREATHING PATTERNS OF RATS. Thomas, R. G.; Morgan, Barbara N. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Fission Product Inhalation Labs.). Sep 1970. Contract AT(29-2)-1013. 15p. Dep. NTIS.

23449 (NP–18726) EIGHTEENTH ANNUAL REPORT, 1969–70. (Australian Atomic Energy Commission, Coogee). 128p. Dep. NTIS (U. S. Sales Only).

An account is given of the activities of the A.A.E.C. in the fields of raw materials (the Rum Jungle enterprise, exploration for, and production of uranium); research related to nuclear power including reactor materials, fuels, water cooling, and criticality studies; radiation research and radioisotope research, production and distribution; operations and services; and various administrative matters including international cooperation. Technical papers published and A.A.E.C. research reports for the year are listed. (Australia)

23450 (NYO–3148-17) FINAL REPORT. (State Univ. of New York, Brooklyn, Downstate Medical Center). 29 Sep 1970. Contract AT(30-1)-3148. 8p. Dep. NTIS.

23451 (ORNL-HUD-15) DEVELOPMENT OF A WET OXIDATION PROCESS FOR MUNICIPAL REFUSE. Boegly, W. J. Jr.; Griffith, W. L.; Clark, W. E. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 41p. Dep. NTIS.

23452 (ORNL-HUD-21) SURVEY OF DESALTING PROCESSES FOR USE IN WASTE WATER TREATMENT. Spiewak, I. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 31p. Dep. NTIS.

23453 (ORNL-NSF-EP–2) ENVIRONMENTAL LAW ABSTRACTS. VOLUME I. Curlin, James W.; Deitchman, Roy W.; Ulrikson, Gerald U. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 49p. Dep. NTIS.

23454 (ORNL-TM-3219) OVEC: A FORTRAN CODE FOR THE CALCULATION OF A DESALINATION PLANT COMBINING VERTICAL EVAPORATORS WITH MSF FEED HEATING. Friedrich, R. O.; Parsley, I. R. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 163p. Dep. NTIS.

23455 (ORNL-TM-3240) AIR FLOW TESTS IN VTE-X TUBE BUNDLE MODEL. Van Winkle, R. (Oak Ridge National Lab., Tenn.). Sep 1970. 65p. Dep. NTIS.

23456 (ORNL-TM-3327) FNEW-PLOTX: AN OVERLAY FOR FOCAL 69 TO OPERATE A CALCOMP PLOTTER. Bell, P. R. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 10p. Dep. NTIS.

23457 (ORNL-tr-2423) MARTENSITIC TRANSFORMATIONS IN LOW-CARBON AUSTENITIC CHROME-NICKEL STEELS. Schumann, Hermann; von Fircks, Hans-Jochen. Translated for Oak Ridge National Lab., Tenn., from Arch. Eisenhuettenw.; 40: 561-8(1969). 19p. Dep. NTIS.

23458 (ORNL-tr-2446) CAGED MICE. Solem, Jan H. Translated for Oak Ridge National Lab., Tenn., from Tidsskr. Norske Laegforen.; 88: 311-14(1968). 11p. Dep. NTIS.

23459 (ORO–3328-17) GRAIN BOUNDARY SLIDING IN ALUMINA BICRYSTALS. Final Report. Palmour III, Hayne; Kriegel, W. W.; Becher, P. F.; Huckabee, M. L. (North Carolina State Univ., Raleigh. Dept. of Engineering Research). Jul 1970. Contract AT(40-1)-3328. 22p. Dep. NTIS.

23460 (ORO–3401-15) EFFECTS OF SURFACE COATINGS ON THE PLASTIC DEFORMATION OF METAL SINGLE CRYSTALS. Progress Report, May 15, 1970–February 15, 1971. Block, Robert Jay (Oklahoma Univ., Norman. School of Engineering and Materials Science). 15 Feb 1971. Contract AT-(40-1)-3401. 6p. Dep. NTIS.

23461 (ORO–3401-16) EFFECTS OF ANODIC OXIDE FILMS ON THE MECHANICAL PROPERTIES OF ALUMINUM SINGLE CRYSTALS. Mehdizadeh, P.; Block, R. J. (Oklahoma Univ. Research Inst., Norman). Feb 1971. Contract AT(40-1)-3401. 64p. Dep. NTIS.

23462 (ORO–3651-9) AN RF METHOD FOR DETERMINING THE AMBIPOLAR DIFFUSION COEFFICIENT OF SEMICONDUCTORS. Cosby, Ronald Maurice (Kentucky Univ., Lexington. Research Foundation). 1970. Contract AT(40-1)-3651. 132p. Dep. NTIS.

23463 (ORO–3817-3) AN INVESTIGATION OF A SYSTEM FOR DISPLAYING COMPUTER OUTPUTS TO THE KINESTHETIC SENSE. Progress Report on GROPE, 1970–71. Brooks, Frederick P. Jr. (North Carolina Univ., Chapel Hill). Contract AT(40-1)-3817. 7p. Dep. NTIS.

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Germanic	ä appears as	ae
Germanic	ö	oe
Germanic	ü	ue
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SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Division of Technical Information* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts*.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF_2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

```
LEAD TITANATES
  PbTiO3--PbZrO3
LEAD ZIRCONATES
  PbTiO3--PbZrO3
```

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
  Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
  Al_2O_3--Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
  acetic acid--BF_3, ...
BORON FLUORIDES
  acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
  bromophenol--chlorobenzene, ...
PHENOL, BROMO-
  bromophenol--chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
  deposition on nuclear fuel particles
  molecular structure of
  neutron total cross section for
  sorptive properties for xenon
  Young's modulus for
  Al--C--Cr, superconductivity in
  B--C, phase studies for
  C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States*, UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
  interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, $\Lambda K(1700)$ enhancement in, (E)
BARYONS, RESONANCE (N^*)
  production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERFRAGMENTS
  binding energy of $\Lambda\Lambda$-He^6, three-body α--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS (TRIPLET)
  hadron total cross sections in quark, numerical analysis of
CURRENT ALGEBRA
  PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
REGGE POLE THEORY
  predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta + n interactions at high energies
SYMMETRY GROUPS
  SU(2) × SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

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Published conference proceedings as well as individual unpublished papers from conferences are included in this index. A CONF number is assigned to the conference if published proceedings are received and also if only a single paper is received. The base number used is year-month-sequence. Thus, the number CONF-650101 indicates that the conference was held in 1965, in January, and that this was the first January 1965 conference so received. This number would be assigned to complete published proceedings. If individual papers are received, the base number is extended to include a paper number, e.g., CONF-650101-1. As additional papers are received, they will be assigned consecutive numbers in the series, CONF-650101-1, CONF-650101-2, etc. This numbering system ensures that all papers received from a conference will be associated with that conference in this index.

If published proceedings are received after the receipt of individual papers, the complete proceedings will be abstracted and the abstract number will appear in this index with the base CONF number.

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